THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 441.

THE COLONIAL AND INDIAN EXHIBITION.

THE inaugural ceremony of this, the last and greatest of the series of South Kensington exhibitions, is proceeding whilst these lines are being penned. We say the greatest advisedly, for although last year's Inventions Exhibition contained more of purely technical interest than the present one, the fact cannot be overlooked that considerations of vastly greater imperial importance are involved in this gathering together of the peoples and products of the whole range of English colonies and dependencies. The fraternal interchange of ideas and the personal intercourse of the natives of widely-separated lands who all own allegiance to one Sovereign Lady, are something more than little-meaning accidents of circumstance, provoking sentiments entertained but for the moment and forgotten or set aside in the aftertime: they are the basis of a deeper, truer loyalty and attachment to the English Crown and nation, the effects of which will become more and more obvious as the years pass on. Those effects, we feel sure, will be not only increased interest in all that pertains to England and to England's Queen, but something more substantial and practical, sturdy support, throughout the British realm, of English national principles, and extension of English commerce. Despite the sneers of other nations and the temptations afforded by precedent to total separation from the mother country, those of our colonies the farthest removed by distance have quite recently shown that they are prepared to do and dare a great deal for Old England; and when the representative men of these and the other colonies find how strong and active here at home is the feeling towards our distant brethren, the bonds uniting us with them can only be drawn the closer. We hail the opening of the Colonial Exhibition as the marking of a distinct epoch in the history of the relations of the various constituents of this great Empire, as the celebration of a period when the colonies were tried and did not fail us.

But a word as to the management of the Exhibition. The doings of the comparatively few people upon whom has devolved the active portion of the arrangements of the past three exhibitions have not given unqualified satisfaction: light is sought to make it quite clear whether private ends have not been made paramount to fair dealing. Arbitrary to the point almost of despotism as has sometimes been the conduct of the ruling authorities within the Exhibition gates, we shall be very reluctant to believe that any great breach of moral honesty has been committed. But their proceedings have been by far too secret, and it is not unreasonable to ask that, for the satisfaction of the public, greater publicity to matters financial, and in fact to all matters relating to the general management, shall be given in regard to the Exhibition just opened. It seems of little use to ask, for it has been asked and not answered, what has become of the large surplus profit on the Health Exhibition, and in what way the deficit arose on the Inventions Exhibition; and although we ask for more openness now we are not at all confident that it will be accorded. This is the unpleasant and unsatisfactory aspect of the Exhibitions which, we admit, have given pleasure and profit to many thousands; it is to be hoped nothing more unsatisfactory may yet occur.

HOW TO WIND MAGNETS FOR SHUNT, SERIES AND COMPOUND MACHINES.

By CARL HERING.

IV.—SERIES MACHINES.

LET it be required to wind the magnets to make it a series machine.

It is evident that this will be much simpler than in the shunt machines, for having given the ampère windings and the ampères, there is no alternative but to make the number of windings $\frac{(a\ \mathrm{W})}{a}$. A few hints, however, in regard to the details may lead to a better proportioning of the parts, and to results which, under the conditions, are the best possible. We will also show how the machine may be regulated for a varying number of lamps.

It is evident that in series machines there is a loss of potential in the current, as it passes through the magnet coils. As the current is the same in the whole circuit, the loss of potential will represent the proportion of power lost in the magnets. This, as with the current in the shunt machine, may be taken at 1·5 to 2·5 per cent. of the total for large machines, and 10 per cent., or even more, for small or cheap machines.

Proceed with the test for determining the ampère windings, the same as described for shunt machines, but in this case excite the field magnets until the desired current delivered by the machine has the required potential *plus* that which will ultimately be used up in the magnets, that is, the required potential for the lamps and leads, *plus* 1·5 to 2·5 per cent. (as the case may be) of this potential, the current strength remaining the same. Call the quantity of ampère windings found in this way (a W).

Continue the test to determine the magnetism curve in the same way as before in order to see whether the machine is properly proportioned, and if not, how to find its proper proportions; also to see whether the machine can be used for more lamps or whether it is overworked.

Having given (a W), and as the whole current passes around the magnets, the number of windings will be

$$\mathrm{W} = \frac{(a\ \mathrm{W})}{a}.$$

It remains now to so select the wire that the loss of potential in the coils shall not exceed the allowable amount; that the coils may be wound full, for the sake of appearance; and that the wire will not heat too much.

The resistance of the coils will be, as stated in considering shunt machines,

$$\mathrm{R} = 50{\cdot}13\ \frac{\mathrm{W}\ l_m\ \theta}{d^2}$$

in which

R is the resistance of all the magnets in legal ohms.

W, the total number of windings on all the magnets.
l_m, the average length of one winding, in inches.
d, the diameter of bare wire in mils.
θ, the specific resistance (metric) at the allowable temperature of the magnet coils.

The current being a, and letting the allowable fall of potential in volts be represented by v, the resistance will also be, from Ohm's law,

$$R = \frac{v}{a}$$

Combining these two and finding the value of the diameter, gives as before

$$d = \sqrt{\frac{50{\cdot}13\ (a\ W)\ l_m\ \theta}{v}}$$

with this difference, that v represents the allowable loss of potential in the magnets, and not the potential at the poles of the machine, as in the case of the shunt machines.

In regard to the mean length, l_m, for an assumed thickness, c, of a coil, the same that was said before, applies to this case as well.

The precautions required for calculating the diameter, d, for shunt machines, in order that the resistance shall not be too large to take the current, are evidently not necessary in this case, for the whole current is compelled to go through the magnet coils. If the resistance should be a little too high, it will only reduce the efficiency of the machine, but will not prevent its working, as it would in case of shunt machines. The factor of safety referred to may therefore either be safely omitted, or may be taken smaller than before. The latter is preferable, as it is always more satisfactory to the constructor to have the final results turn out to be inside of the limit placed than beyond it.

The factor of self-induction in the coils, which acts to apparently increase the resistance, is probably the most important to allow for in this factor of safety. It is difficult to say what to allow for it, as it depends on so many quantities, such as the number of windings, the number of commutator strips on the armature, the speed of rotation, the current in the coils and the nature of the iron. For ordinary machines we suppose 5 to 10 per cent. will be a sufficient factor of safety to cover all these. Instead of introducing the value of v directly into the formula, we therefore take 95 to 90 per cent. of v.

Taking, as before, the value of θ equal to ·0162, and assuming a temperature of 70° F., the formula becomes

$$d = \sqrt{\frac{\cdot 875\ (a\ W)\ l_m}{v}}$$

in which d is in mils., l_m in inches, and v the allowable loss of potential in volts, which should be first reduced as above described, to include the factor of safety.

But this may give a diameter which is so small that the wire will heat, which will be the case if the magnets or the ampère windings are small or if the allowable fall of potential be large. In that case, the diameter will have to be determined by the heating effect, and not by the allowable resistance. It is necessary, therefore, to calculate the proper diameter from both the above formula and the heating effect, and then take the larger value of the two. For the heating effect it is safe to take ·001 ampère per square mil of cross section of wire, which is equal to 1,000 ampères per square inch. This figure, as will be noticed, is smaller than that given for shunt machines, for in the latter the wire being smaller, it will cool off more rapidly. For large, compactly-wound magnets, however, the difference in cooling of large and small wires will not be great, so that both this constant and the other may be varied slightly.

Having found the two values of d, and chosen the largest, take the nearest gauge number or size, to this value, and find its diameter, d_1, outside of the insulation. Having given the number of magnets and the length of one magnet core, e, we can now determine the number of windings per layer from our formula—

$$\frac{1{,}000\ e}{d_1}$$

in which e is the length of a core in inches, and d_1 the external diameter of the wire in mils.

The number of layers will in this case have to be calculated from the number of windings, and not, as in the shunt machine, from the allowable thickness of coil c; for in this case the value of W is determined at the outset by the current, a, and the ampère turns (a W), and there is no deviation from it.

The thickness, c, must therefore be calculated from W as follows: Let n be the number of magnets, then the turns per magnet will be $\frac{W}{n}$, and the number of layers will be

$$\frac{W}{n} \times \frac{d_1}{1000\ e}$$

from which the thickness, c, can be readily calculated

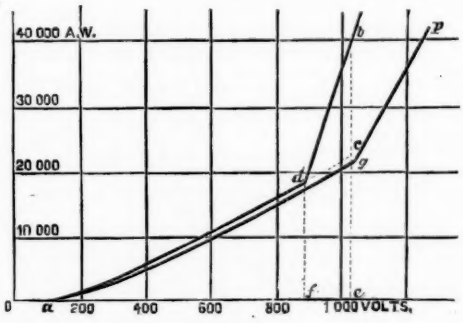


FIG. 2.

by multiplying this by d_1 and reducing to inches. It can be calculated directly from the formula—

$$c = \frac{W\ d_1^2}{1{,}000{,}000\ e\ n}.$$

If this is about the same thickness as that which was assumed, then, provided the wire does not heat, and that the magnets are not over saturated, the machine is properly proportioned, and there remains only to calculate the resistance or fall of potential as a check, and perhaps to alter some parts slightly for the sake of the appearance of the magnets; that is, that they may be wrapped full. This will be described later.

If this calculated value of the thickness, c, is found to be much smaller than the assumed thickness, and if it is found from the magnetism curve, as described in the beginning of these articles, that the magnets are just saturated, then it shows that the magnets are too long, and they may be advantageously shortened. The cores may be shortened to such an extent that for the same ampère turns and diameter of wire, the thickness of coil c is about that which was above assumed; that is, the length, e, of a magnet, in inches, may be made,

$$e = \frac{W\ d^2}{1{,}000{,}000\ n\ c}.$$

If, on the other hand, the thickness found from the formula is much larger, and the magnets are just saturated, it shows that the magnet cores are too short, and they should be lengthened to the amount required by the formula just given.

If the magnets are very much over saturated, then it only remains either to use the machine uneconomically or to use it for less lamps, or to increase the size of the core so that from the magnetic curve the magnets are seen to be just saturated. For instance, from the magnetic curve find at what point, that is, for what ampère windings, the magnets are saturated. Divide this by the number of magnets, and then by the cross section of a core in square inches; this gives the saturation coefficient, or the allowable ampère windings per square inch of magnet core, for that shape of core and for that

quality of iron. Having determined this constant, it is easy to calculate what the size of core should be in order not to be over saturated, for that quantity of ampère turns, which this particular machine requires. If m is this allowable density of magnetism, the required cross section in inches should be

$$\frac{(a\ \mathrm{W})}{m\ n}.$$

But this will do only for a slight increase or decrease, as it is only approximately correct, and it may, for an increase in core, be safely taken a trifle smaller, because, when the core is increased in cross section, it will no more take the same number of ampère windings to produce the same amount of magnetism than when it was over-saturated as it was in determining the ampère turns. It will also require less ampère windings to generate the same magnetism, for the reason that the same current passing through a coil with a larger core, but with the same ampère turns, will produce more magnetism in proportion to its linear dimensions, and therefore will require less ampère windings to produce the same magnetism. This can be demonstrated as follows :—In a single winding, the intensity of magnetism produced by a certain current is less in proportion as the diameter is increased; that is, for twice the diameter it is half as great; but the total magnetism is proportional to the intensity and the area, and is, therefore, proportional to the linear dimension, because the area increases as the square of the diameter and the intensity inversely as the diameter; therefore the total number of lines of force will increase as the diameter. For instance, if the diameter of a coil is doubled, the intensity will be halved, but as the area inclosed is four times as great, the total magnetism, being the intensity multiplied by the area, is twice as large.

For this reason, and because there will be less ampère turns required in the new cores when they are not over-saturated, it will be better, when the increase is comparatively great, to determine the new cross section more accurately than by the first method, by proceeding as follows :—

Take the curve of magnetism, a, b (fig. 2), below the saturation point, d, and continue it with about the same rate of curvature beyond the point, d, where it takes a decidedly different direction. This will then be approximately the curve which the machine would have if the magnets were not saturated, but at the same time, if the area of core were the same. Through this new curve drop a perpendicular, b, e (representing the magnetisation), on to the line, o, e, through the point, b, at which the machine was tested, then the point, c, where this line intersects the new curve, will give the ampère windings represented by c, e, which would be required on the new machine to produce the same magnetisation if the cores were not saturated and if they were of the same size. Call this number of ampère turns (a W′) represented by the length of the line, c, e; call the distance, d, f (a W″), and let the required number of ampère windings of the new machine with larger cores be (a W); then

$$(a\ \mathrm{W}) = \sqrt[3]{(a\ \mathrm{W}')^2\ (a\ \mathrm{W}'')};$$

thus giving the required number of ampère windings directly. The deduction of this formula would not be in place in this article; it is sufficient to say here that it represents that number of ampère windings which will be required by a larger core, to generate the same total number of lines of force, at the same allowable density of magnetisation (or coefficient of saturation), and considering the fact that the larger the area of the core the less the ampère windings. The application of the formula will be illustrated later by an example.

Having determined the number of ampere windings, find the new cross section of core by dividing it by the number of magnets and the coefficient of saturation obtained from (a W″) and the area of the old cores.

If the core, in the original machine, is found to be very far from being saturated, the magnets are unnecessarily large in cross section, and they may be diminished in a similar way as above described.

Having now determined the proper cross section of the core for the new machine, calculate from the new number of ampère windings (a W) what the diameter of wire should be, and from this as before, the thickness, c. This is then the thickness required when the new magnets are just saturated, and if this is much larger or smaller than the new assumed thickness, it shows that the magnet cores are too short or too long, as above described. The new length may be determined directly, without first calculating c, by the formula previously given.

If the curve of magnetisation is found to be a regularly curving line without an abrupt change of curvature, it shows that the iron is not well distributed in the machine or that it is very hard. It shows that it does not saturate all at once, as it should, but that at some parts it is too small in cross section, so that they saturate sooner than other parts. But this is a subject to be treated by itself, as it cannot be discussed here; it is sufficient to say here that all the parts of the complete circuit of the lines of force should have the same degree of magnetisation throughout the machine; if they have not, then some parts are too large or some too small. If the iron is soft and the curve does not show one decided point of saturation and only one, there are no doubt some wrong proportions in the sizes of the iron masses. There is no harm in having too much iron at any point, only that it makes the machine uselessly heavy, and therefore not of the most economical proportions.

If the curve shows no decided point of saturation and it cannot be discovered where the weak point in the magnetic circuit lies, then the magnetisation may be continued up to what seems from the curve to be the limit of economical magnetism, or for cast iron oval magnets, up to about 240 to 250 ampère turns per square inch of core.

THE EDISON "PHONOPLEX" OR "WAY-DUPLEX."

WHILE the duplexing of through telegraph lines is now an easy matter and largely applied, the problem of increasing the capacity of lines employed in way service, such as upon railroads, says the *Electrical World*, has up to the present received no satisfactory solution. The ordinary duplex requires a fixed condition of the line, and when that varies even slightly it must be compensated for. Evidently, with twenty or thirty stations on a railroad line, or ordinary way offices, the communication with each office on the usual duplex plan would require a separate balancing for each one, and as one office is called up after another there would be a constant changing and loss of time. Besides, the ordinary duplex would not permit of two independent offices communicating with one or two other offices, and hence its value would be greatly restricted; indeed, its successful application would be well nigh impossible.

With these drawbacks in mind, Mr. Edison has devised a most ingenious method of doubling the capacity of telegraph lines, whether employed on way business or through traffic.

The name which he has given to the system, the "Phonoplex," or "Way-Duplex," suggests immediately an application of the telephone, and such is indeed the case.

While Mr. Edison's method of working is analogous to that of Van Rysselberghe in his system of simultaneous telegraphy and telephony over the same wire, he, nevertheless, has an entirely different object in view, and that is, to convert the telephone on the circuit into a sounder, so that the regular Morse can be read from it.

Before entering into a description of the details, it may be well to give a short outline of the principle employed.

It is well known that if the emission and extinction of the current in the telephone be gradual, the diaphragm will be merely bent, and will return to its original form without emitting a sound. But if the make and break in the current be rapid, the telephone diaphragm will "snap," and so give forth audible sound. If now there are included in the same circuit a telegraph relay and a telephone, we may, by manipulating a key, operate the relay (and sounder) without producing a sound in the telephone, as the makes and breaks at the key are too gradual. But if through the same circuit we send the rapid discharge current from the secondary of an induction coil, or the extra current from a primary, it will cause a loud click in the telephone, but the current is too weak to affect the telegraph relay. Hence, by sending two kinds of currents over the wire, we obtain two effects which can be readily utilised for the purpose above described.

There are of course several points which must be observed in practice, and these have been well worked out, as will be seen in the diagram, fig. 1, which represents the equipment and arrangement of circuits in each office. The whole may for convenience be divided into the Morse and the "Phone" branch, although in

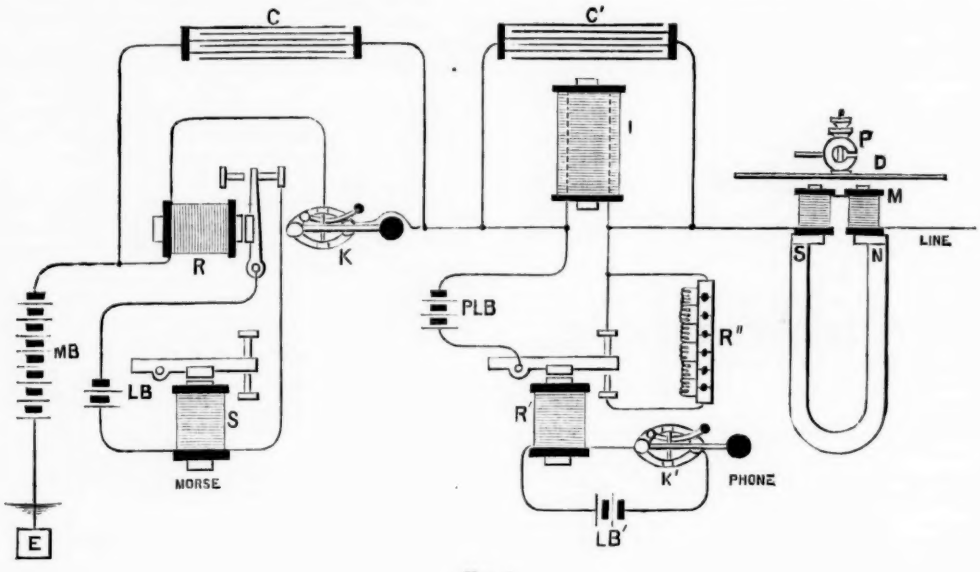


FIG. 1.

reality there is no branch, as in the ordinary duplex—the line being continuous through both.

The Morse circuit at the left consists of the ordinary relay, R, sounder, S, and key, K. In addition, however, there is a condenser, C, placed as a shunt around the relay and key, the function of which will appear presently.

The "phone" circuit shown at the right contains the phone-sounder, with permanent magnet, M, diaphragm, D, and will be described more in detail below. The phone local battery, P, L, B, is in circuit with the primary coil, I, which is always included in the line circuit, and also has a condenser, C', connected to its terminals. The circuit coming from one terminal of the coil, I, is split, one branch going directly to the back stop of the relay, R', and the other to the front stop, but including a variable resistance, R''. The phone operator manipulates the key, K', as usual.

For the sake of clearness, we will suppose that the Morse circuit is not at work. The circuit would then be from line through the phone, thence through coil, I, through key, K, relay, R, battery and earth. But in addition the current has a by-pass through the condenser, C. Now, when the phone operator closes his key, K', the lever of the relay, R', breaks the circuit of the primary coil, I, and the intense extra current of short duration is sent over the line. The effect of the extra current and the rapidity of discharge is still further increased by the condenser, C', which is placed there for that object. This intense and rapid extra current does not affect the relays on the line, but passing through the condenser, C, acts powerfully on the diaphragms of the phones, and gives a violent motion to the snapper, P.

It will be noticed that every movement of the lever of the relay, R', sends two impulses over the line—one on breaking the circuit and another on making at the front stop. The extra current produced by the latter, however, is greatly diminished by the resistance, R'', and follows so quickly upon the first that there is but one click heard in the phone. When the armature lever of the relay, R', is released by the raising of K', the reverse operation takes place, for we then have first a weak extra current over the line followed by a stronger one. This change in the order of the currents causes a difference in the sound emitted by the phone, just as in the ordinary sounder the sound of the front stroke differs from that of the back stroke. In this way the signals received in the phone can be clearly distinguished.

Thus far we have supposed that the Morse operator is not working. From what has gone before, however, it is evident that it makes no difference whether his key is closed or not, as the condenser, C, is all sufficient for the transmission of the high potential phone current.

In addition to the gradual emission of the Morse current which the operator's key produces, there is also added thereto the retarding influences of the relays in circuit and the primary coils, I, which then have the same functions as when applied to the Van Rysselberghe system, in which they act as "graduators." While offering no reduction in speed to the Morse working, they "graduate" the emission of Morse currents so that they merely deflect the diaphragms of the "phones" without snapping them and producing a sound.

Though a variable resistance, R'', is used, it is merely for the purpose of varying the sound in the "phone" to suit the operator's ear, and once set is never disturbed.

The "phone" itself is a simple and ingenious apparatus, and is shown in section in fig. 2. Resting upon a wooden base is a hollow column of brass, within which is placed a magnet with the bobbins facing the diaphragm. At the lower end of the magnet there is a rack and pinion, by which it can be adjusted with reference to the diaphragm. To the centre of the latter there is attached a screw-threaded pin, with thumb nut and binder at the top. Encircling the pin loosely is a split-hardened steel ring which rests upon

the diaphragm. When the latter is snapped by the attraction of the momentary current in the magnet, it throws the ring violently against the stop-nuts, and produces a sharp click, far louder than that from the ordinary sounder. The steel ring has a pin projecting from its side that passes between two prongs, which, while permitting free up and down motion, prevent the ring from turning and altering the sound. Over the top of the "phone" there is clamped a thin brass plate as a protection for the projecting screw.

This phonoplex system is especially valuable for railway telegraphy, but is equally well adapted for regular lines, and is already in operation in various

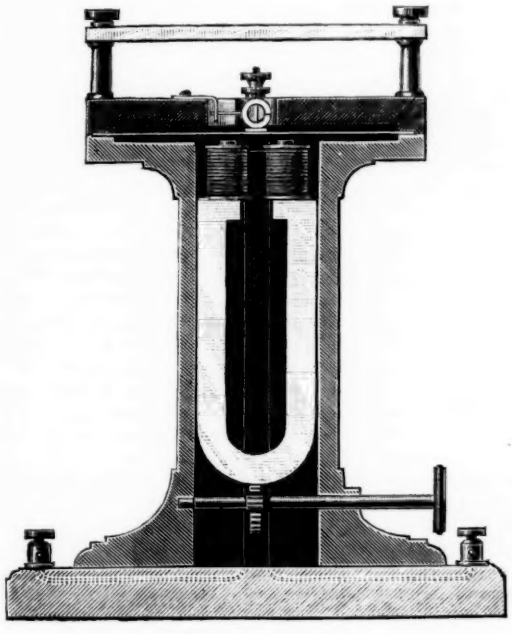


FIG. 2.

places. Several city lines in this city are equipped with it, and the Baltimore and Ohio Telegraph Company and Railroad have it in operation between Baltimore, Harrisburg, and Pittsburgh.

The "phone" local battery only requires three to four cells for the longest distances, say two or three hundred miles. As stated before, the operation of the system is extremely simple, and the condition and length of the line has no effect upon the working.

THE HUMAN BODY AS A CONDUCTOR AND AS AN ELECTROLYTE.*

I HOPE I was able to show in my second lecture the effects of polarisation which occur in all electrolytes, and in the human body to an extent not previously measured, so far as I know. I also showed the important bearing of these physical effects on the physiological observation of electrotonus. But, before I proceed to the subject of to-day's lecture, I have to acknowledge my faults, I have to confess my sins. In the first place, in the skeleton of Mance's method a minus was omitted between the two terms of the numerator and friction, A − B. I will not condescend to say whether that was my fault or not; but it certainly led me to describe the formula as one of multiplication. The product divided by the sum is so familiar a formula to electrical workers that the mistake was natural. But the method really is the difference of two quantities, and very compound quantities, both of them, called A and B, divided by a third compound quantity called C. I understand that the mistake was so very obvious, that I need not occupy more time in explaining how it arose.

Dr. Ord has suggested to me that I did not make the demonstration of the two sounds in the induction discharge quite so clear by the telephone as I ought to have done, and, therefore, I propose to do it in another way to-day, and as it were to carry the practice of oscultation, so well known in this college, a step further. I have arranged a contact breaker, and I will ask you to take the telephones whilst I perform the experiment as I think more satisfactorily. I shall make and break so very slowly that what by habit has become easy to me will be easy to you. Now, the tick is double, but it is distinctly audible, like the tick of a lever watch. That has been made a great physiological point of, but it is reproduced here, without physiological apparatus, without the galvanoscopic frog, entirely by means of the telephone. Here I will end my confessions, and I am now enabled to begin the subject of to-day.

I have to speak to-day of induced currents, and the subject of induced currents has been gone over and over again in every text book *ad nauseam*. I do not wish to repeat all that can be read therein. The current of induction is momentary; it occurs at make and break; it occurs in the second wire; but it can also occur in the same wire, and when occurring in the same wire it is called the extra current. The current on making is weaker than that of breaking, because the extra current in the first wire antagonises the make and assists the break. A sort of momentum is obvious, and this antagonises the action which is going on. Now these induction currents came very early into physiological and therapeutical use. They succeeded, indeed, very soon upon the attempts to produce a frictional current, which date from before the present century, and the reason, I believe, of this is, first of all, from their obvious effect on the sensory nerves; secondly, from their valuable action on muscles as stimulants; and, thirdly—and on this point I need not insist—from the remarkable work done by Duchenne some thirty years ago.

Now, I recollect Duchenne well when I was in the hospitals of Paris about 1856, and there cannot be the least doubt that he, with a very clumsy and primitive induction coil, accomplished, by patient labour, a most marvellous work. He isolated several new nervous diseases. He tested the reaction of muscle to stimulants, and he made quite a new era in our knowledge of electrical stimulus. But the current used by him was not specially or specifically electrical. He had a good muscle stimulant. His coil was merely a convenient way of testing the susceptibility of muscle, and it had no great electrical value. This has done some damage to subsequent electrical work, because it has been taken for granted that the convenient stimulus which he used in the induction coil had some bearing on electricity. In the higher branches I believe it has none. For testing the contractility of muscle it is still unequalled. It is also most valuable as a means of keeping up irritability of muscle which has been damaged by the impregnation of lead, or from which by nerve injury, or more deep-seated lesion, the motor nerve influence has been cut off. But we must recollect that this machine of Duchenne is a muscle stimulant; it is not a nervous stimulant. It is not necessarily an electrical phenomenon at all. No doubt it might be used also, though with more caution, to test sensation. But here individual differences of temperament step in, and the tolerance to induced currents is extremely various in different persons. This has been discounted by the class of people who attend fairs and exhibitions, and who have an enormous machine with a vast amount of bright apparatus on which they ask you, for the remuneration of one penny, to test your strength. All you test in a case like this is

* Concluding lecture by Dr. W. H. Stone, M.R.C.P., delivered at the Royal College of Physicians, April 15th, 1886.

your particular susceptibility to a certain amount of induced current, and this no doubt varies very much. If the points were taken np scientifically, something might be made out of it; but even this is not really an electrical phenomenon.

No doubt induced currents, may go a stage further, and do good service in stimulating even so deep seated a muscle as the diaphragm in asphyxia or in suspended animation. In cases of opium poisoning I believe the induction current should be used, one pole to be over the nape of the neck and the other pole moving about in front of the abdomen, because it will excite efforts of respiration when hope seems lost. In the lecture room it is a convenient and effective means of physiological demonstration; but there its use ought to end. Even in physiological research it is unsafe, and I very much regret that some recent and valuable researches as to the localisation of brain functions have been founded on the use of induction currents. And, firstly, for this reason, that there is not only no proof that the current passes through the region included between the poles, but there is very conclusive evidence, I believe, that it diffuses itself widely and irregularly in all directions with enormous differences, according to small differences of conductivity. But, secondly, I may even say it is very doubtful if a current passes through a moist substance like the brain tissue at all. I have to show you that it is possible and probable—I believe that is true—that it only starts a series of laminated polarities in a bad conductor, which resembles very much the laminated condition of a condenser. For this reason I spoke of the condenser in my syllabus, and although I had withdrawn the term, I think there is something like a condenser action in this laminated, this polarised state, which the opposite currents from an induction coil may produce in a feeble conductor. However, when I speak of induced currents of that kind I mean the currents obtained from an induction coil.

You can make induction currents by a totally different method from this, and if they are to be used with any certainty they should be used after another fashion—I mean alternating currents obtained by commutating battery currents. Here you are able to measure the electromotive force of the battery.

Now, I had intended to speak of these alternating currents as produced by a tuning fork, but I have found this would pass beyond my limits of time; besides, in the next place, I shall show you presently that it is not necessary further to investigate it, because, as a matter of measurement, it must be thrown aside. But the measure of induction currents is a question of some importance, and of the more importance because, in reading a medical periodical a few months ago, I saw a review which commenced by the general statement that it is impossible to measure induction currents. Now this, strictly speaking, is not true, and I shall proceed next to show you three methods by which induction currents can be measured—first of all by Kohlrausch's dynamometer. But it is too delicate to be shown in a lecture room. It is very good indeed in the silence and quiet of the laboratory. It may be briefly described as a galvanometer in which the moving needle has been replaced by a moving coil. The instrument is in very great use in electrical investigations, but it is hopeless to produce any demonstration with it in a lecture like this. I therefore prefer to take the two simpler and rougher modifications, which answer medical purposes better than that.

I have two here which will answer all medical purposes quite sufficiently, and which are not so difficult to demonstrate. Here is, first, my old dynamometer, which went across the Atlantic with me to the British Association meeting at Montreal; and here is another one, but which, I believe, has not been employed before in this particular way, and in which the whole trouble of having a current through a coil is removed by using a sheet of soft iron. The first I will describe as a coil made of light aluminium wire. Without the electrical contact the aluminium is a substance which for a given bulk is the largest conductor of electricity. By making an aluminium coil you get a light and moving coil, which will act under our small currents. But even that I have since found can be dispensed with. I do not claim to be the discoverer of it; it was discovered in Italy; but I have made with my own hands an instrument, using a coil from another galvanometer. which will demonstrate this very well. If instead of an aluminium coil through which the current is passing, you take two sheets of ordinary or soft iron, they so rapidly change their polarity that they are equivalent to a coil in which a magnetic force is developed. Two soft iron sheets are mounted here between two coils; I shall not waste very much time on this experiment, and I will only just turn the handle of the exploder, which produces a moderate induction current in alternating directions—quite tolerable by the human being—so that this is within the range of what we can stand and use. Now, there I have induced magnetism in these two plates of iron, and I think that will be the dynamometer of the future for medical purposes. It avoids so many complications and difficulties.

But a far better and more accurate determination can be obtained by that most beautiful instrument, the quadrant electrometer. The quadrant electrometer, like the dynamometer, is far too delicate to attempt to demonstrate with in a lecture room, but I have made determinations with it, in which I had the valuable assistance of the professors of Cooper's Hill College, and it is the united work of myself, Mr. Gregory, and Prof. Stocker that I thall reproduce here. I have given two formulæ by which the determination on the electrometer can be made. I do not intend to lay much stress upon it now, but the general principle of it is this—that if the currents are alternating, the needle of the Thomson electrometer must be put in communication with one of the quadrants, preferably with one of the quadrants and then the other. The upper diagram is that given by Prof. Adams in his Cantor lectures, and in the other diagram there is the mode of measurement given me by Prof. Hopkinson. Time will not allow me to dwell upon them; but I will give you a *résumé* of certain determinations made in that way with a fine quadrant electrometer at Cooper's Hill. The process we adopted was to compare the deflection obtained on the electrometer, that is the difference of potential with an alternating current with that of a battery of which we knew the force and which we could measure.

"In these measures," says Mr. Gregory, writing to me, "the negative pole of the battery was to earth, the positive pole being connected at will to either pair of quadrants, and the needle also at will to either pair, giving four readings for each observation. I give only the means which agree very well." The determinations are ·149, ·151, and ·146 each, which gives a mean ·1486. Using the mean value we worked out that the electromotive would give a deflection of 107, which we got. It came out 38. Then we took the same determination with the same electrometer, with the same constant and batteries, and it came out 107·25. "This agrees very well," says Mr. Gregory; so that it will be very easy to value the E.M.F. corresponding to any deflection by the formula which is made here.

We then tried the making and breaking of contacts about ten times a second. The deflection was obviously somewhat lower, so that possibly the effect of rapid alternations is to lessen the deflection for the same electromotive force. But observations seem to point to this, that the mean electromotive force developed by the induction coil is certainly less than 50 volts, and probably nearer 40. I think we may take it at 40. Of course, this is not the maximum E.M.F. Even the electrometer integrates to a certain extent. But still, this measurement, which I think has not been made before, may be taken as sufficient for all our purposes.

We have made a measurement—and a successful measurement—of the force of an induction coil of the ordinary form, and this, instead of being 8 or 10 volts, is at least 40, and may go quite up to 50. Now, I want to show you a curious result that comes from using

this induced current of from 40 to 50 volts passing in an alternating current through the human body; and here again I shall have recourse to my telephones, for I have discarded the galvanometer for the more sensitive and delicate telephone. I shall introduce the human body into the circuit, and I shall use for this purpose Kohlrausch's combined induction coil and meter bridge with the telephones. Here the electromotive force which is working it is only four volts—two bichromate batteries—and I will ask you to put a telephone to your ears. I have a quarter of a metre here of fine platinum silver wire, and a number of fixed resistances, so I will employ a hundred resistances, and then I will employ a thousand, but I am afraid my human patient will not stand it, and when I get balanced you will find that the telephone will cease to speak.

I get 600 ohms against 1,100 given by the constant current. Now, this is very important. The same man whom we tested at the first lecture only shows 600 ohms resistance, whereas to the constant current he shows 1,100, and this is invariably the case, and I believe the observation is absolutely new. Of course, however, the first result of it is that it is clear that this induction current cannot be used for the measurement of human resistance. We lose something there. But, on the other hand, we get physiological facts of very considerable importance, and the explanation of this difference is what I will next proceed to consider. It is susceptible of several explanations. In the first place, the human body, like all imperfect conductors, in all probability is more permeable to high tension than to low tension currents. This occurs in all feeble conductors. I think the effects of these experiments alone fairly prove this, and there are many that you come across in telegraphic work which prove it. Indeed, the diagram we had last time, when we used an E.M.F. of two volts, four volts, six volts, and eight volts, showed a distinct falling of resistance as the E.M.F. was increased. But there is a great deal more than this. It is probable, as I said before, with the rapid intermission, the current does not pass at all, or not fully, until it is met and annulled by the next current in the opposite direction. Thus the body would be like the leaves of a book in a stratified or laminated condition, or more closely like an elastic body transmitting the waves of sound with alternate plates of condensation and rarefaction represented in this case by positive and negative polarities. Now, curiously enough, this comes out from Du Moncel's early and successful experiments. He found that there was inside the charged body something like the leaves of a book. There was the new polarised current obtained at the extremities, and at first giving an opposition current, which soon yielded to the old current which had been established internally. This seems to me to be a proof that the body can take up a series of laminated polarities, and does not transmit these induced currents.

But there is a third reason which, I think, ought to be considered, and that is, as Dr. Oliver Lodge has suggested to me, that an alternating current ought to show too low a resistance because of the electrochemical capacity of the body which the current would treat as conductivity—the reciprocal of resistance. If we were to measure the resistance of a perfect condenser with alternating currents it would not come out infinite even if the insulation were as perfect as it could be made. Here, again, was the reason for my putting into the syllabus that there was something like a condenser action in the human body. Lastly comes the fourth point, and, as I believe, there is considerable self-induction. Now, self-induction is a word which involves a great deal of difficulty. It is to be avoided in all induction coils, and in all resistance coils. The possibility of its playing a considerable part in the actions now before us was brought strongly before me only two months ago by a highly suggestive paper by Professor Hughes read before the Society of Telegraph-Engineers on January 28th of the present year. He gives a very good account, and a very perfect account of what is known of self-induction. Induced or secondary currents in a double circuit were discovered by Faraday in 1831. The phenomenon of self-induction, or an electric current on its own wire, was observed by Henry in 1832, and enlarged upon by Faraday in 1834. He proved that by sending a current through a wire a momentarily induced current in the opposite direction is evoked in its own wire, and also on the cessation of the primary current excitement is induced on the secondary.

I will not go further into that now. What I have to note here is that Professor Hughes makes two different periods—the stable period and the variable period. The ordinary current from the battery is not in itself used—is not tested—until it has got to the stable period, but the induction current is in the variable period. There is some controversy as to the mathematical interpretation of these facts; but my own belief is that in the main they point to a new direction of research which may be utilised by physiologists. He divides the current into stable and variable periods. The continuous current is stable, and the interrupted variable, so that it is in the latter that induction takes place. Professor Hughes has brought his improved method of investigation forward in place of the time-honoured Neef's hammer, as in Du Reymond's coil. He uses his own invention, the microphone, or, still better, a small contact-breaking clock. This enables the ordinary meter bridge to be used for measuring resistance, and if time allowed me I would show how it works. But you may combine this mode of measurement with Professor Hughes's sonometer. I have here a simple form of the sonometer, in which the induced coil slides along a bar. As I slide this along the bar I think you will be able to detect the effects of induction.

I am very glad to have been able to show what I believe is a perfectly new experiment, and I will admit that it is somewhat difficult to show. If these coils be set up at measured distances, and an interrupted current passed through the primary coil, the patient, and a known resistance in the secondary circuit on either side of the telephone, good measurements can be obtained. There is a still further modification of the instrument that I do not propose to go into to-day. This is Professor Hughes's last discovery. He blends together a Wheatstone bridge and a sonometer, by which I hope we shall be able to balance, if it will act, not only resistance but self-induction. I have not been able to make any definite measurements yet. The instrument has only been before the public since January, and this particular instrument, which takes some time to make, has been in my hands only for a fortnight or three weeks, but I think, if I cannot give exactly the measurements, I can give demonstrations which will enable you to see what it means.

But whilst this is being put up I will occupy your time by a few general considerations. I think I have been able to show you that here is a great field for future research—that the whole basis of physiological electricity requires strengthening and re-examining. It is a stately building built by Du Bois-Reymond and many others, of which the foundations are unsafe. Until these are made firm the whole superstructure is in danger. But if, on the other hand, we set to work and strengthen the foundation we shall in the course of the necessary explorations come on many precious discoveries. Already the analogies between the nerve force and this great physical force—electricity—are becoming very strong, and one such, on inhibition, was published in *Nature* by Dr. Lander Brunton. He took up the theory. (I hope it may be true) that different lengths of nerve conductors might transmit wave influences at a period such that there should be interference, and so inhibition might occur; and I ventured at the end of my syllabus to place another such attempt to go out into the infinite unknown, by saying that there are many analogies between the condition of the human body and a duplexed Atlantic submarine cable.

The curious thing about the submarine cable is that

its results are produced at the far end, and that nothing is shown at the near end. How like this are many nervous actions of the human body! When you see these strong analogies you cannot resist the impression that nature must have worked upon one plan, and although we have not found it there must be some link between the two. I do not wish to lay any stress on the duplexed cable other than that it produces on my mind, and it may on yours, a strong feeling that the analogy is too great not to be in a certain sense real, although not yet discovered. And we are coming upon this every day. It is a most desirable thing that we should come upon this, because every connection that can be found between physical facts and that unknown vital region which we have been accustomed to investigate is one step further on the road to truth, one of the mysteries taken out of the unknown and added to the known.

I shall conclude by offering a few observations as to what are the hopeful directions of electrical work. I see the therapeutical use of electricity looming before us in the direction of muscular enfeeblement, palsy, and what has been called reflex action. I am not quite certain of its value on the sensory nerves in cases of neuralgia. I mentioned and gave you the details of a case of sciatica, which I have no hesitation in saying was instantly and momentarily cured by a continuous current. I believe it is of great value in neurotic cases, such as locomotor ataxy. It has the power of loosening chemical compounds in the body. Therefore, it follows that it should be an eliminative, and that I am absolutely sure it is, because I have extracted from a fellow creature by electrical action 3 milligrammes of copper. The same thing has been done often and often with mercury.

I think that concludes what I have to say on the subject of electricity. But beyond that I have something to say. I have to thank you all. I have had the intelligent support of my colleagues. I have been honoured by the presence of my brother censors, and I have received the greatest kindness from all connected with the college. I have had the patronage besides of men not belonging to the medical profession, like Sir Henry Mance—an honour which I cannot too highly appreciate—and I have enjoyed the careful attention of many of my students. I thank you all sincerely, and I will finish by a well-known formula, thus reviving a time honoured practice of this learned body:—

Dixi quod felix faustumque sit hinc collegio.
Vos omnes volete et plaudite.

ABSOLUTE SPHERICAL ELECTROMETER.

By M. LIPPMANN.

THIS instrument is essentially composed of an insulated metallic sphere which is brought to the potential, V, sought to be known. This sphere is divided into two hemispheres movable in relation to each other, and which repel each other with a force equal to f when their system is electrified.

We have between V and f the simple ratio easily demonstrated

$$f = \tfrac{1}{8} V^2.$$

To find V it is therefore sufficient to measure f. This measurement may be effected by various procedures, of which I prefer the following:—

At first, if the apparatus intended to measure f was outside the metallic sphere, we should be obliged to place it at such a distance that it should not exert any appreciable disturbing action on the electric distribution. I prefer, therefore, to place it entirely in the interior of the electrified sphere, which is hollow.

One of the hemispheres is fixed; the other, movable, is suspended by a trifilar system, that is to say, one composed of three vertical wires of equal length. When the repulsion is produced the movable hemisphere can only be displaced parallel to itself, the three suspending wires forming then a small angle, a, with their original vertical position. We measure a by the method of reflection by means of a small mirror cemented to two of the wires and visible through a small aperture. If we call p the weight of the movable hemisphere we have

$$f = p \tan. a$$

and consequently

$$p \tan. a = \tfrac{1}{8} V^2.$$

It is therefore sufficient to know the weight, p, which is invariable; as for the radius of the sphere, its value is evidently indifferent.

In a second specimen of the same instrument which I have the honour of submitting to the Academy, the system of the two hemispheres is contained within a concentric spherical envelope of copper which is placed in communication with the earth. This arrangement increases the sensibility of the instrument and secures it against currents of air and external electric perturbations.

If we call a and b the radii of the two concentric spheres we have

$$= \tfrac{1}{8} \frac{b^2}{(b-a)^2} V^2.$$

Here $a = 3{\cdot}9$ cm.; $b = 4{\cdot}92$ cm.; $p = 3{\cdot}322$ grammes.

It follows that if we place a scale divided into millimetres at 1 metre we have as the value of the deviation

$$d = 0{\cdot}00373\ V^2.$$

If we express V in volts we have

$$d = 0{\cdot}0000140\ V^3.$$

It is advantageous to multiply the sensibility of the instrument optically by reading off the deviations by means of the eye-piece of a microscope magnifying from 15 to 50 times, as was recently proposed by M. d'Arsonval. We thus diminish in the same ratio the deformation—which, moreover, is very small—which the system of the two hemispheres undergoes in consequence of the deviation.—*Comptes Rendus.*

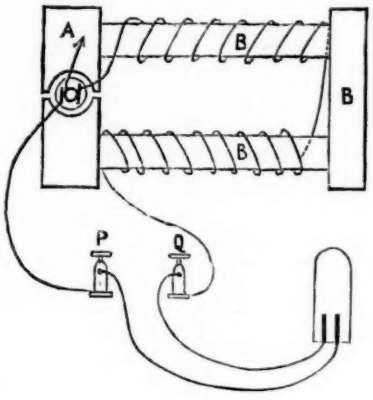
DECOMPOSITION OF WATER BY MEANS OF A DYNAMO MACHINE ROTATED BY HAND.

By J. W. GILTAY.

SOME time ago the following phenomenon was communicated to me: An attempt had been made to electrolyse water by means of a small hand dynamo machine, but although the machine was rotated as rapidly as possible, there was no evolution of gases observable. Accidental communication was established between the terminals by which the leads were connected to the platinum electrodes, and the decomposition of the water followed at once; when the terminals were shunted by a metal wire of a resistance of a few ohms, the liquid was likewise electrolysed.

In the subjoined diagram a represents the gramme ring, and b the field-magnet of a small hand dynamo; a and b are wound in series with thick wire, and the pole terminals, p and q, are connected to a voltameter. As soon as we now begin to rotate the armature, it moves in a feeble magnetic-field which owes its existence to the weak residual magnetism of the field-magnet. So long as the difference of potential between the terminals, p and q, remains less than 1·4 volt, no current will pass through the voltameter, that is to say, if we leave the very feeble convection currents out of the account, it follows that no current will circulate in the coils of the field-magnet; the number of the lines of force remains consequently constant. If we cause the ring to revolve more

rapidly, the number of lines of force cut across by the coils of the ring in the space of a second will be proportional to the velocity of the rotation. If we could rotate the machine by hand with a sufficient velocity, the difference of potential between p and q would soon reach 1·4 volt, and the liquid contained in the voltameter would be decomposed. It was, however, not possible to attain such a velocity with the machine with which the experiments were made. But the case



is different if we connect the terminals, p and q, by a metal wire as well as by the voltameter. As soon as we cause the armature to rotate, a certain difference of potential is set up between p and q, in consequence of which a current passes through the wire, p, q, and further through the whole circuit. The strength of the field is thereby increased, consequently the currents induced in the coils of the ring acquire greater intensity. The difference of potential between p and q will now rise more rapidly by an increased velocity of rotation than in the former case, because the number of lines of force in the magnetic-field increases. In a short time the difference of potential between p and q will amount to 1·4 volt, and the current will divide itself into two branches: one part will pass through the voltameter, and the other part through the shunt wire; the current strengths in both branches of the circuit are inversely proportional to the resistances; and electrolysis of the water will consequently take place.

The cause of this phenomenon is obvious enough, and I would not have mentioned it if it had not induced me to make another experiment, which, as far as I know, is novel, and which shows very clearly that an iron core requires a certain space of time to lose its magnetism. I proceeded as follows:

The terminals, p and q, were connected by a copper wire of very low resistance. However rapidly the armature was rotated, not the least decomposition of the water was observable. Probably the difference of potential between the points, p and q, which were connected by a conductor of very low resistance, was less than 1·4 volt; it is, however, possible that the difference of potential reached, or even exceeded, 1·4 volt, but if that was the case, only an extremely small quantity of electricity would pass through the voltameter in consequence of the high resistance of that branch of the circuit, and the fact that as good as no evolution of gases at all occurred is therefore easily explained. The Gramme ring, in this case, moved across a very powerful magnetic field, as was evident from the great amount of energy required to work the machine.

I inferred now that the field-magnet would not lose its magnetism suddenly on the interruption of the shunt connection between p and q. If my inference was correct, the armature would after the disconnection of the shunt still move for a moment across a powerful magnetic-field. The difference of potential between p and q, now separated from one another by the great resistance of the liquid, would then possibly amount to 1·4 volt or more, and the decomposition of the water would set in; and as then, in that case, a current would circulate in the voltameter and, consequently, also in the coils of the field-magnet, the field of b would retain a certain intensity, and perhaps it would be possible to observe in this way, with a sufficient rapidity of rotation, the continued electrolysis of the water.

This experiment completely confirmed my theory. Whilst p and q were joined by the short shunt, there was no evolution of gases observable even with the greatest possible rapidity of rotation; but when I disconnected the shunt whilst the armature was being rotated, the evolution of gases set in at once and continued as long as the rotation was maintained. When I stopped the machine for a moment and then set it in motion again, no decomposition of water would take place unless I had first shunted p and q for an instant.

When two voltameters joined in series were connected to the terminals, p and q, gases were evolved in both after the disconnection of the shunt. This evolution of gases diminished, however, rapidly, and ceased altogether after the lapse of about one second. By this experiment I could, as it were, *see* the field-magnet gradually lose its magnetism.

As soon as the decomposition of the water ceased, it was evident from the greater ease with which the armature was rotated, that considerably less energy was required to perform that operation.

SELF-INDUCTION.

THE discussion and controversy which has been occasioned by Prof. Hughes's interesting paper on self-induction, not only shows the importance of the subject as well as the interest it has excited amongst electricians in Europe and America, but it also brings to light the manifold ways in which it is criticised, commented upon, and even discredited.

In asking you for space in your valuable journal for the following lines, my object is not to enter into a discussion with Prof. Hughes's critics, but to offer a few remarks on the physical aspect of the subject of self-induction, in explanation of the various phenomena presented to us in the experiments and their results; because I feel convinced that such phenomena are better explained when submitted to physical in contradistinction to mathematical reasoning, and I am prepared to be called "ignorant" by mathematicians when I confess that I cannot comprehend how mathematics, the science of magnitudes, can be employed to prove physical facts—to prove the cause of water being lifted by a suction pump, or the cause and nature of electric or magnetic induction. Mathematics can determine *the relations of* magnitudes, either in numbers or in space; with its aid we can interpret the results of experiments, but we cannot by means of it prove the cause and nature of physical phenomena; and I consider it is to the discredit of mathematicians when they (or Mr. Oliver Heaviside) ask us to believe that their formulæ contain an explanation of the results of Prof. Hughes's experiments. Prof. Ayrton very properly remarked that: "the increased resistance that Prof. Hughes has shown us to exist in a wire through which an intermittent current is flowing . . . . . could be anticipated from the ordinary mathematical calculations . . . . . if *one had a complete knowledge of nature*." Quite so! Experiment should go hand in hand with logical reasoning and the employment of mathematics; but the latter science can only serve to complete and to qualify the former.

Among the many unexpected results obtained by Prof. Hughes, there is one which I think deserves more than ordinary attention; it is the fact that the self-induction in an iron wire is considerably reduced when the wire is coated with copper. I do not think it has been referred to either in the discussion or in the subsequent correspondence; yet it seems to me to

assist greatly in explaining the very result which is questioned by Prof. Weber, and, further, in enabling us to get a better insight into the nature of self-induction. So far as I remember, the only speakers in the discussion who looked upon self-induction as a purely physical phenomenon were Profs. Forbes, Thompson, and Ayrton. Prof. Forbes, with a certain emphasis, declared that the electromotive force (of the induced current) was strongest in the centre of the wire; hence here would be the strongest induced current; and by inference we must conclude that Prof. Forbes considered the primary current to flow through the conductor nearer the circumference, since both primary and induced current could not possibly exist in the same portion of the wire simultaneously. For it is not easy to conceive that the primary current when starting in the central portion of a circular conductor should *there* create an E.M.F. (Prof. Forbes does not say in which direction) in the same direction as the primary current, and so cause an induced current contrary in direction to the primary. Prof. Thompson declared that he was "perfectly aware that in the case of a solid circular conductor the current, when first turned on, and when it is rising in strength, rises in the outside before the inside," and he thinks this is evident, since "that is accounted for by the counter-electromotive force of self-induction in the interior of the solid conductor." But, I ask, where is the proof that the E.M.F. which produces the induced current is strongest in the centre? Prof. Thompson adds: "I cannot but think that the proof Prof. Forbes describes has got some little fallacy lurking at the bottom of it."

Prof. Ayrton (with Prof. Thompson) could not agree with the view stated by Prof. Forbes, &c., &c.

I here beg to offer a physical theory of the nature of self-induction (or induction generally), and beg the reader to accept the remarks for what they are worth.

In a uniform magnetic field we can assume parallel lines of magnetic force, and at right angles parallel lines of electric flow, as roughly illustrated in fig. 1, in

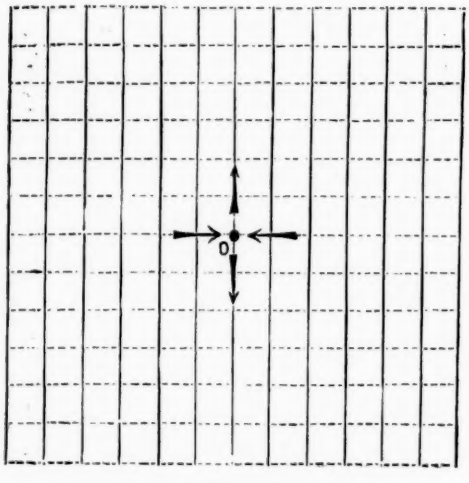


FIG. 1.

which the dotted lines represent the magnetic, and the solid lines the electric lines of force. Taking any point, *o*, in that field we have, in the direction of the magnetic lines of force *attraction*, and in the direction of the electric lines of flow *repulsion*, as verified by well-known experiments. And since no lateral attraction exists between conductors until a current flows through them, we can assume that the attraction takes place also between the lines of electric flow *in one and the same conductor*. From this we should be justified in assuming still further, that when a current is sent through a conductor, let us say of circular section, it, the current, will flow through the central part or axis of such conductor, but, heating this portion of the wire and so increasing its resistance, will spread towards the circumference, still always with the tendency of concentration towards the centre.

From the fact that an electric current of sufficient strength will cause disrupture of a conductor, we can assume that even a comparatively weak current causes a strain in the conductor in proportion to the strength of such current. Let us make an attempt to illustrate this by representing the longitudinal section through the centre of a wire, as shown in fig. 2, in which a current is started from *a* to *b*. Its effect would be to separate the atoms situate along the central line; but through their cohesion amongst themselves and the adjacent atoms this effect would impart itself to these latter, and in this way spread towards the circumference, C, C, of the conductor. And further: this

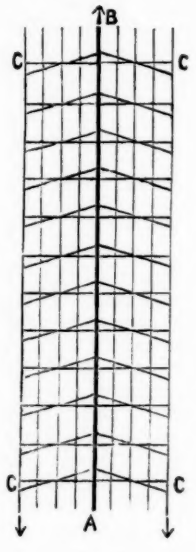


FIG. 2.

disturbance in the cohesive force along the central line of the conductor in the direction from *a* to *b* would cause a similar disturbance amongst the atoms along the circumference of the conductor in *the contrary direction*, until the balance of the forces, acting between the atoms under this continued strain, had been re-established, or until the strain caused by the primary current had diffused itself across the whole section of the conductor. This accommodation or adaptation of the atoms of the conductor, which takes place when a current is started, and which requires a certain time to be accomplished, would in itself explain the retardation in the establishment of the full primary current; and the reaction of the central portion of the conductor upon the circumferential parts (or upon a separate conductor adjacent to this primary current) would explain the formation of the induced current. We can in a similar manner conceive how the extra current is produced when the primary current in the conductor ceases and so causes the normal cohesive balance between the atoms to be restored. It may be retorted here that I assume cohesive force between the atoms as equivalent to electric force. Well, I take my standpoint on this, since I think that the production of electricity by friction or compression, as well as by chemical action, rests on the act of setting free or disturbing atomic or molecular cohesion; hence the universal and indestructible nature of electricity.

The question here arises, to what an extent does this central disturbance in a conductor spread laterally towards the circumference or surface of the conductor when considering wires of different diameters to be subjected to our experiment (of *starting* an electric current). It would naturally suggest itself first that the magnetic character of the metal, but secondly also the nature of the metal with regard to ductibility,

elasticity, &c., must have some influence upon it; but, I think, so also must the current density; that is, the proportion existing between the strength of the current and the section of the conductor. With the same strength of current, let us gradually increase the diameter of the wire experimented upon. We can conceive that, with an increased section, the number of atoms which have to be acted on in starting a current in the conductor also increases, and that the retardation of the main current in starting becomes greater in proportion to the greater number of atoms agitated. Yet it must be remembered, also, that this lateral action would exhaust itself by reason of the elasticity in the atomic structure of the metal. Hence, when increasing the diameter of the wire, with a constant current, we, no doubt, increase the retardation in starting a current; but this should cease sooner or later, with increased diameter, according to the nature of the metal; and beyond this, *i.e.*, with further increase of diameter we should have a stronger induced current in the outer ring of the conductor, which, by *its reaction*, would assist rather than retard the main current. Prof. Hughes's table, as given on page 12 of the *Journal of the Society of Telegraph Engineers and Electricians*, comes in here to support me, although Professor H. F. Weber (see ELECTRICAL REVIEW, No. ccccxxvii., of April 9th, page 321, second column, line 20 from below) thinks these tabulated results "*contradict*" THE VIEWS "*hitherto in vogue in electrodynamics.*" Quite so! since these views are based simply on the influence which magnetisation of a conductor has upon self-induction, and since, in their mathematical calculations of the co-efficient, the diameter alone is brought in as a factor, and not the nature of the metal as referred to above. Prof. Weber forgets that, between two separate conductors, we grant to the intervening substance, such as air or india-rubber, a special inductive capacity; why should we not also do the same when the question arises of an induction in the same conductor which carries the main current, leaving magnetisable metals out of the question.

The facility with which the induced current can establish itself will, no doubt, also react on the main current. Let us return to our iron wire, which we consider of comparatively a large section. When a current is started, circular lines of magnetic force will be established round the axis, causing an induced current through the conductor in the contrary direction *near its surface*. The larger the diameter the greater the number of atoms acted on, at the same time the larger the section of conductor for the formation of the induced current. Now, let us place a coating of copper round this iron wire, and the result will be that, although we have increased the number of atoms through which the induction takes place, we have supplied a conductor of considerably less resistance. The result is a stronger induced current which, reacting on the magnetic iron wire, assists the primary current, and so apparently lessens the retardation in the formation of the full primary current.

Applying this theory practically, we should obtain the best result, *i.e.*, apparently least self-induction, by taking a copper wire as a main conductor, encircling this with iron wire (in the manner in which pianoforte wire is covered), and placing outside this iron covering a ring of copper in separate wires or strips.

C.—*Copper conductor.*
I.—*Iron wire twisted round inside conductor.*
O.—*Outside copper wires or flat strips for developing induced currents.*

From the above theory we might draw the inference that there is a limit at which an increased section of a conductor will reduce its resistance in proportion to such increase.

With regard to the experiments to prove the existence of self-induction and to determine its magnitude, I shall have to say a few words on Prof. Hughes's apparatus; but I know that he is large-minded enough as a worker in scientific research to pardon my presumption in making some suggestions as to the form of apparatus and the nature of the experiments. With your permission, I shall make this the subject of my next communication.

C. GODFREY GÜMPEL.

Burstow, Surrey.

THE STRANGE HISTORY OF A DYNAMO

As told by itself to

A. DYNAMICABLE.

[*All rights reserved.*]

(*Continued from page* 397.)

SCIENTIFIC men, at the time of which I am speaking, were much engrossed with my doings, and considerable speculation was doubtless excited in their minds as to finding ways and means for my further development. It naturally occurred to some to duplicate the various members of my frame, and to fashion me after the manner of the Siamese twins. Others still further multiplied my parts, and of course correspondingly increased effects were forthcoming from the source of my extraordinary powers which was ever in a perfect whirl, a whirl, too, of constant excitement, a state in which I suppose I shall end my days.

Indeed, it is absolutely essential for my vitality that I should be subjected to this continuous round of excitement, for otherwise I become perfectly inanimate. It was not until the year 1849 that a decided opening was given to me for industrial purposes, an opportunity for which I had long been patiently waiting. M. Nollet, a professor of physics in the Brussels Military School, constructed in that year a large machine based upon the form given to me by Mr. Clarke. You can readily conceive within your own mind how the task of transforming me into a multiple apparatus could be carried out, and I then presented an appearance which can be described in a few words.

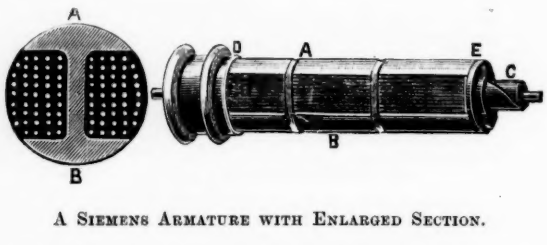
My framework was of cast iron, carrying 40 steel magnets of the horse-shoe form. These were symmetrically and radially arranged in eight rows of five each with their poles turned towards the centre. In the spaces between the magnets and attached to a horizontal axis there revolved four brass discs each carrying 16 single electro-magnets or bobbins similar to those which I showed you but a few minutes since when trying to explain to you the action of the commutator. You will understand, therefore, that there were in all 64 of these bobbins, and that during one revolution of the discs carrying these, each bobbin had its magnetic polarity reversed 16 times. There were then no fewer than 1,024 electric impulses or currents of the alternating kind developed within me in a single revolution, and if you will imagine me being driven at say 200 turns per minute and in operation for producing the electric light for which purpose I was afterwards set, a simple calculation will show that the number of my alternations per minute amounted to 204,800. I was overhauled and modified here and there by Prof. Holmes, the Count du Moncel, a man who has done much towards the popularisation of electrical science in all its branches, and others, and although still producing alternating currents only, I had now become of much importance in the world, and for the first time I was thought of sufficient value to be energetically taken in hand with the view of turning my wonderful capabilities to account. This led to the formation of a company called "The *Alliance*," with which I was allied, but as I was called upon to effect objects for which I was not yet quite suited, and which, indeed, were visionary and illusory in themselves, the company, and with it my alliance came, as might have been expected, to an untimely end. So ended my first experience in a commercial sphere.

Thanks to the perseverance and skill displayed by

Prof. Holmes who would not acknowledge me to be a failure in any way and notwithstanding my unfortunate connection with the *Alliance* Company, I was finally and in a still more improved form, installed in the Dungeness Lighthouse in the month of June, 1862, from whence, through the medium of an electric lamp, I shed at night upon the anxious mariner a light which, to quote the illustrious Faraday, was "so intense, so abundant, so concentrated and focal, so free from undershadows and from flickering, that one cannot but desire it should succeed." To what extent this wish of the great philosopher has been brought about you can see for yourself in these days of what is still the "light of the future."

In 1856 was patented by Dr. Werner Siemens, of Berlin, an improvement in the method of producing electric currents which may be termed the most important innovation since the days of Pixii. Previous to this the electro-magnets, or revolving coils of magneto-electric machines, did not turn in a very *intense* magnetic field, and the invention which I now bring before your notice was, although most simple in itself, of great practical value.

It consisted of a soft iron rod or cylinder, A, B, of a length regulated by requirements. A deep groove was cut in the ends and along each side of the cylinder, and in this groove was coiled a long length of insulated copper wire. To its two ends were secured the brass discs, E and D respectively. With E was connected a commutator, C, of simple construction, consisting of two pieces of metal insulated from each other as here shown, and connected respectively with the two ends of the wire.

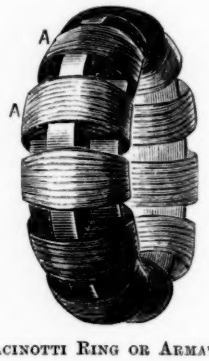


A SIEMENS ARMATURE WITH ENLARGED SECTION.

On the other disc is a pulley by means of which the complete cylinder, known technically as the *Siemens armature*, can be rapidly rotated between the poles of a magnet or electro-magnet. When this is done the sides, A, B, become alternately magnetised and demagnetised, and a series of alternating *positive* and *negative* currents are thereby produced as in Clarke's form of machine. The principal advantage which this armature of Dr. Siemens possessed lay in the fact that owing to its peculiar construction it could be placed between the poles of magnets which were brought very close together, the magnetism acting upon the revolving copper wire, or the "magnetic field" through which the coils rapidly passed, being thereby rendered more intense.

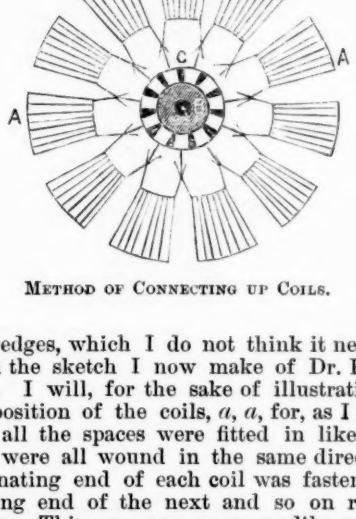
I had frequently asked myself how long I should remain in this "alternative" form, for I was firmly convinced that sooner or later the man would be found who would so remodel me as to enable me to produce *continuous* currents without the aid of a commutator to redirect my alternations.

Such an inventive genius was personified in Dr. Pacinotti, of Florence, who, in the year 1860, constructed a machine which is virtually the prototype of nearly all the dynamos existing at the present day, the leading examples of which you see before you in this very building. The Pacinotti armature was a complete departure from anything which had preceded it, if we except the ring armature of the electro-motor devised by Elias, of Amsterdam. This, however, was not I think ever intended to act as a dynamo proper, or generator of electric currents, so it suffices merely to make mention thereof. Yes, an electro-motor is really the reverse of a dynamo; the latter is driven mechanically and produces a current which can be utilised for a variety of purposes, the electro-motor is *supplied* with an electric current from an independent source, and it is then available for performing mechanical work. Understand me, however, that the dynamo proper is convertible, *i.e.*, a good dynamo will also act as a good electro-motor, but this was only practically found to be the case at a more recent period than that of which I am now speaking. To return to the Pacinotti armature: this consisted of a ring of iron around the circumference of which were 16



A PACINOTTI RING OR ARMATURE.

teeth or projections of equal size and at the same distance apart. The notches or spaces between these teeth were filled up by coiling them with insulated copper wire, these coils being firmly held in their places by



METHOD OF CONNECTING UP COILS.

wooden wedges, which I do not think it necessary to include in the sketch I now make of Dr. Pacinotti's invention. I will, for the sake of illustration, show you the position of the coils, *a*, *a*, for, as I have just observed, all the spaces were fitted in like manner. The coils were all wound in the same direction, and the terminating end of each coil was fastened to the commencing end of the next and so on round the entire ring. This you can more readily understand by this diagram in which I show you a few coils only, leaving the ring upon which they are wound out of the question for the moment.

You will notice that this winding forms a *closed circuit* of insulated copper wire with a certain number of points where the end of one coil is soldered or screwed to the end of another. These junctions were attached to just as many slabs of metal or contact pieces arranged round the surface of an insulating cylinder of boxwood, but the contact pieces were kept carefully apart from each other, so as not to be in metallic connection *across* the boxwood cylinder. The only communication, therefore, between slab and slab was by means of the coils of wires to the ends of which they were attached as you see in the figure. Here *a*, *a*, are the coils, *b* the boxwood cylinder placed upon the axis on which the ring revolves, and *c*, *c*, are the contact slabs, to each of which the beginning of one coil and the end of its neighbour are attached. I have, in this

illustration, shown you only 11 coils, but in my original form, as moulded by Pacinotti, I was burdened with 16. How the current was developed within my ring and the manner in which it was collected for "external application only" I will now explain to you.

(*To be continued.*)

ON THE THAMES IN AN ELECTRIC LAUNCH.

SCUDDING along on the bosom of Father Thames, without sign of oar or sail or steam boiler! Truly it was a delight and a wonder—a delight to us who were favoured with a seat in the boat, and a wonder to the craft we passed and to the spectators who soon gathered on pier and bridge and embankment. No visible motive power, and yet we shot through the water at a rate which quite out-distanced the bull-dog tugs, and even caused consternation and surprise on the bridges of the larger steamers carrying passengers.

Surely here was a second Captain Nemo with his electrical boat, which moved or was still, answered the helm with or against the tide with equal ease, and perhaps—who knows—even descended into the water, at the will of the owner! She did not explore the depths on Saturday, though, and no one was sorry, for she did not seem altogether fitted for submarine travel. One attempt, indeed, she made, but nobody appeared to like it, so to the surface again she returned. Perhaps the gentleman in command thought he would give us a taste of what the boat could do if necessity arose, but had pity on us when he recollected that no provision had been made for going to the bottom of the Thames. Or perhaps it was only that she shipped a sea in the rough water in the Pool, and our excited imaginations immediately suggested that we were to be submerged. At any rate, we got wet, and let it be distinctly understood that we preferred to remain, for the present at least, fair and square on the top of the water.

We met on Charing Cross Pier: quite a number of electrical celebrities arrived a little later; and presently, up the river came Mr. Reckenzaun's wonderful little launch, with two or three ladies on board, Mr. Reckenzaun himself, Mr. Stephens, and the assistants required for the management of the boat. Simultaneously with their arrival, there came on to the pier a turbaned Hindoo (I am not sure that he was a Hindoo, but he *was* turbaned and was of Oriental appearance, so that's sufficient), who, with astonishing temerity, walked straight to the edge, and, without hesitation or apparent misgiving of any kind, descended into the launch as though he had known it all his lifetime and it had come now particularly for him. The others, not quite so stolid, stayed to remark on the boat's appearance and calculate its capacity, to greet its occupants, and to assist the ladies to *terra firma*. (Is that pier "*terra firma*," by the way?) It was clear there was not room on board for all who were prepared to commit themselves to the mercy of the waves—(there *were* waves)—so something like thirty souls went off first for a short cruise, and as many, or more, waited. "The anchor's weighed!" roared Mr. Stephens, and the boat was steered away in the direction of Westminster; without passing under the bridge, it crossed the river, came back on the other side, and recrossed.

I do not think anything very exciting occurred on the first trip; nor, indeed, on the second. But subsequently we had quite an adventure. "Boat ahoy!" shouted a "jolly young waterman," making straight for our boat. (I did not hear him say "Boat ahoy!" but that is the proper thing to say, and no doubt he said it.) Visions of pirates, of highwaymen on the river, for a moment made me wish myself safe on the Embankment; but I was soon reassured when I saw that the j.y.w. could not keep pace with our little clipper, and heard him call for nothing more dreadful than "Your license!" The youth at the rudder was addressed, but for all notice he took of the demand he might have been as great a stranger to the language of the waterman as he probably was to that of the turbaned Hindoo. Our boat did not stop, and the other began to fall behind, although "young Tom Tug" made desperate efforts to keep alongside, all the while shouting for the license and commanding us to stop. All his skill, however, was futile, and presently he desisted from the attempt to overtake us, and contented himself with yelling that he would make us "Pay for this," and shaking his fist at us. On the return journey, when he saw us coming, he again made for the middle of the river, but he hadn't time to get within hailing distance before we passed the point for which he was making. I had observed this young man rowing about the river previously, and eyeing very closely the mysterious little boat, which he did not seem quite able to make out. Evidently he came to the conclusion that it was illegally plying for hire, and he resolved to put a period upon its operations. He must have been chagrined by the way in which the occupants of the demon boat ignored him and his importance.

Mr. Stephens entertained us with a description of the main points of the launch; and a man readier with anecdote *apropos* I never encountered. "How thick are the plates?" enquired a passenger. "One-sixteenth," replied Mr. Stephens. "Only one-sixteenth!" "Ah, you are like the man who built a boat with plates three-sixteenths of an inch in thickness, and would not trust himself in it upon the water because there would be but three-sixteenths of an inch between him and eternity!"

Many more lively little stories like this kept us all in good humour; and Mr. Stephens had a happy way, too, of giving us the information we desired to possess respecting the boat. "She has a very peculiar bottom," he told us; "and, upon my word, I believe she would turn on her own centre." With a length of 37 feet and 6 feet breadth of beam, the launch was fully capable of carrying comfortably 40 persons. Seats ran around the sides, and the passengers faced each other. She was built some time ago by Yarrow & Co., the famous torpedo boat builders, and is intended for the service of the Italian Government, who will use her for general harbour purposes, laying torpedoes, and other work for which she is peculiarly adapted. The arrangement of the motors, the secondary batteries, and the switches, which are all out of sight, is precisely the same as that in vogue on the tramcar system devised by Mr. Reckenzaun, and which the ELECTRICAL REVIEW has fully described.

We had ample evidence of her powers of speed, for she was put through her paces for our benefit on a straightaway run from Westminster Pier to Charing Cross Pier. Mr. Gisbert Kapp timed her as doing just two minutes. This distance, according to the map, is about 730 yards, and a rough calculation since worked shows that the speed attained was at the rate of close upon 12½ miles an hour. Somewhat faster than that accomplished by the *Great Eastern*, which found it difficult in its journey to Liverpool to get above 5½ miles an hour. Of course, we had the tide in our favour. When upon her trial on the measured distances at Greenhithe, the boat showed an average speed of 9½ miles an hour with the tide, and of 7½ miles against it. These, however, were at the ordinary working speeds, and when we timed her she was under what may figuratively be termed "high pressure." Fifty miles, on another occasion, she accomplished in six hours: very satisfactory work.

Well, the boat behaved capitally on Saturday, and the three-score or so of interested visitors were highly pleased with her performances. Those who left her at Charing Cross, particularly, had nothing to damp their satisfaction; the few who returned to Millwall with her were not quite so fortunate; but then it was only that the water just below London Bridge got a little inquisitive, and the top of a wave jumped in to see for itself what made the boat move. That was all. But the consequence was that, although but tyros in electrical navigation an hour previously, we immediately became "wetter uns."

AN APPARATUS FOR REPRODUCING AT PLEASURE AN INVARIABLE QUANTITY OF ELECTRICITY.

By M. MARCEL DEPREZ.

THE instrument which I have the honour of submitting to the Academy has for its object the easy reproduction, at any time and under any conditions of pressure and temperature, the quantitative unit of electricity which has received the name of the *coulomb*.

It consists of a U-tube, the two limbs of which have been sealed at the lamp and terminate in glass balls, the volume of which is much more considerable than that of the cylindrical portions. One of the balls, as well as the corresponding limb, is completely filled with water, acidulated with phosphoric acid; the second limb contains likewise a little of the same liquid in its lower portion, but in the greater portion of its length it is filled with air at a given pressure, as is also the ball in which it terminates. The limb filled with liquid has four platinum wires fixed in pairs opposite to each other, one pair in the upper part of the ball and the other in the cylindrical portion, a little below the bottom of the ball. If an electric current is directed into the two latter, the water is decomposed and the detonating mixture resulting from this decomposition accumulates in the upper ball whilst the liquid driven into the second limb ascends in it, compressing the air in the second ball. If we take care to note the point of departure of the liquid column in the second limb, which is divided into parts of equal capacity, as well as the point at which it stops on suppressing the current, we have all the data necessary for knowing the quantity of electricity expended in producing the detonating gaseous mixture. It is easy to see that if the volume of this mixture, measured by the rise of the liquid in the second limb is always the same, the quantity of electricity needful for its production will likewise be invariable, and this whatever may be the temperature of the instrument, provided that it is the same in the two limbs, a condition easily realised.

As for the barometric pressure and the hygrometric condition of the air, they have evidently no influence on the result, since the tube is hermetically sealed. Lastly, the liquid being always the same, it will be seen that this instrument allows of the reproduction, whenever required, of a quantity of gas corresponding to an invariable quantity of electricity taken as a standard, the operation consisting simply in reading off a volume, which is always the same, without any correction being required; whilst with the ordinary voltameter, the corrections for temperature, for pressure and vapour-tension can by no means be neglected.

In order that the instrument may serve indefinitely, it is necessary to reconstitute the water decomposed at each operation; this is the purpose of the platinum wires situate in the upper part of the balls where the detonating mixture accumulates. It is sufficient to pass a spark between these wires to induce the combustion of the detonating mixture. The acidulated water again fills the ball, and the instrument is ready for a fresh operation. The apparatus may be made more or less sensitive by filling the second branch before sealing with air of a greater or less pressure than that of the atmosphere.

As to the use of this instrument for graduating instruments intended for electric measurements, I think it is useless to enter into details.

This instrument has been submitted to numerous experiments, in which its indications have been compared with those of the ordinary voltameter, with all the corrections required for temperature, atmospheric pressure, &c. These experiments, made with great care by M. Minet, one of the engineers attached to the experiments at Creil, have shown that the indications of the new apparatus are fully trustworthy.

Electric Lighting of Mills.—The Manchester Edison Electric Light Company is installing 400 lights at the mills of Mr. Robert Platt, of Stalybridge.

THE BLACKPOOL ELECTRIC TRAMWAY.

"A BOROUGH SURVEYOR" has made the Blackpool electric tramway the theme of a discourse to the *Engineer*, and what he has to say thereon will probably be found worth reading, if only as showing the points which the particular genus which the writer represents regard as important to be taken into consideration.

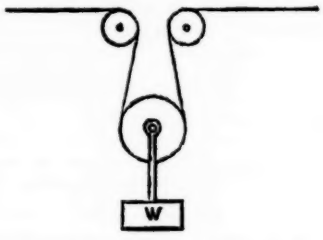
He says: "In the *Engineer* of 1st January last a description of this tramway was given, with illustrations of its principal details. Reference was made to other tramways previously constructed in Ireland and on the Continent in which electricity was used as a means of propulsion, but the line constructed at Blackpool is the first in which electricity has been used in such a way as to meet the requirements of an ordinary street; it is free from the obstruction to traffic which would be offered by an overhead conductor, as at Berlin, or one raised a foot or so above the surface, as at Portrush, in Ireland, and it is free from the inconveniences, and even dangers, attending the use of a conductor exposed in the surface of the streets, as in those systems where the rails themselves form the conductors. In this letter the tramway at Blackpool is looked at from a borough surveyor's point of view, and although some of the remarks made may not seem favourable, it must be understood that they refer to the details of the tramway only, and do not affect its general principle; the criticisms are offered in the hope that they may be serviceable in improving the system, it being the writer's opinion that the best way of perfecting a thing is to eliminate its defects, and that a good way of getting this done is to have the defects clearly pointed out.

"There are good reasons why the opinions of a borough surveyor on tramway matters should differ from those of a civil engineer. The borough surveyor's primary object is the care of the streets, and to see that the tramway does not injuriously interfere with them, nor be a source of danger to the public, nor cause a nuisance or obstruction to ordinary traffic, nor in any other way interfere with the rights of the public to whom the streets belong. It will be readily imagined that the borough surveyor's ideas will not always coincide with those of the tramway engineer on these matters; the borough surveyor will object to many things that the engineer probably prides himself on as models of mechanical perfection, and he may even sacrifice this mechanical perfection if by so doing he can attain other objects which he is bound not to lose sight of. In a public street the best of tramways is always more or less of a nuisance, if nothing worse, except, perhaps, when it is at its best. A rail may stay where it is placed, but a paving stone generally will not, especially when laid adjacent to a rail—it may sink under the weight of ordinary vehicular traffic, and it certainly wears away faster than the rail; so that, however carefully the rail and the stones may have been laid together, sooner or later the rail is found to be projecting above the general surface of the pavement, which consequently has to be taken up and relaid. Now, as the tramway is laid at Blackpool the surface of the road is cut up by three or six, instead of by the two or four rails of an ordinary tramway, according as the line is single or double, and the evil arising from the projecting rails is therefore intensified in the like, if not in a greater, proportion.

"Apart from the question of using three rails instead of two, objection is here taken to the construction of the middle rail or rails forming the top of the tube. The way in which these rails or beams are formed need not be here described, as they are clearly shown in the figures illustrating the article above referred to. The beams are too light in themselves, and too slightly attached to the cast iron frames carrying them and determining the outline of the tube, for them to withstand for long the heavy traffic of a town; and furthermore, there are too many short removable pieces in these beams, forming covers to 'hand holes' for access to the joints in the copper tubes forming the electric main conductor. It may be contended that since it is necessary to have means of access to the joints, it is necessary to have the short removable pieces in the rails; but the rails are under consideration here, not so much as forming a part of the tramway, but as forming a part of the roadway, and as such their construction is objectionable. The form of construction adopted will lead to the disintegration of the joint between the rail and the paving setts, for the beams will deflect and shake loose under the traffic, and the joint will open; the 'racking' and 'grouting' in the joints between the paving setts will be wasted out into the tube below, and the paving setts thereby being left unsupported, will sink under the traffic, leaving the beams or rails projecting above the street surface and forming a serious obstruction to vehicular traffic.

"As the necessity for this method of constructing the top of the tube seems to arise from the method adopted of forming the electric main conductor, viz., of split copper tubes, which can only be obtained in lengths of about 30 feet, and as the use of soldered joints is inadmissible owing to the difficulties arising from expansion and contraction under changes of temperature, it is suggested that the copper tubes be replaced by a copper wire cable, or cables. The cable could be obtained in any length the engineer liked to ask for. It could be supported on hook-shaped insulators within the tube, and by putting a tension upon it, it would be no difficult matter to keep it in its place. Without entering into details, it would seem quite feasible to apply, at such intervals as might be found to be necessary, tension weights attached to a pulley hanging in the bight formed by passing the cable over two insulators—which might also be pulleys—placed close together, as shown in the sketch. The use of the cable and weights, as proposed, would not only get rid of the difficulties arising from

expansion and contraction, but would render the frequent 'hand-holes' in the surface of the street unnecessary. It would also enable the number of insulators to be very largely reduced. Every 'insulator' must be a source of leakage, and therefore



waste, especially in wet weather, and the fewer there are of them the better. The fewer they are in number, the farther the line could be carried away from the dynamos supplying the electricity with a given percentage of loss, and the less power would be required for working the line.

"This question, however, is perhaps more properly the concern of the tramway company's engineer than that of the borough surveyor. But it may be remarked that some years ago water-works companies did not object to a few leaky pipes and defective house fittings. Many of them have since found out that all water pumped into the mains and not used and paid for by their customers has to be paid for by the company themselves, and it is probable that a somewhat similar rule will be found to apply to companies supplying electricity. Repairs to the cable could be performed by drawing it into suitable manholes provided at distant intervals in the streets, or it might even be possible to draw the cable through the tube into the engine depôt.

"Objection must also be taken to the collector—or that portion of the apparatus which connects the motor on the car with the electric main—being dragged along by a cord. It should be a rigid attachment to the car, and strong enough to force aside any obstruction in the slot that could be 'removed by hand.' The breaking of a cord stops the car and blocks the road, and if the driver has not another one to replace the one broken it might cause a serious interruption to the traffic, especially on a single line. Some years of experience of cable tramways shows that the slot is not more likely to get blocked than is the groove in an ordinary rail; and even if the collector itself were not strong enough, or not suitable for clearing away anything that might perchance get into the slot, a strong cow-catcher could be fixed in front of it which could clear the way for it.

"Objection is also taken to the use of wood for forming the sides of the tube. However carefully the wood may be creosoted or pickled, it will not for long stand the heterogeneous nature of the liquids to be found on the surface of a town street. Sooner or later it will decay and cause the collapse of the sides of the tube and the sinking of the surface of the road.

"The last objection, but by no means the least, must be to the middle rail itself, or rather, to putting the tube containing the electric conductors in the middle between the two ordinary rails of the tramway. It will be seen that in some respects this tramway resembles a cable tramway, but on a cable line there is a good mechanical reason for putting the cable tube in the centre: if it were put elsewhere the gripper would cause an oblique pull on the car, and a side pressure on the flanges of the wheels and on the rails. Whatever may be the force of this reason on a cable tramway, it cannot apply to an electric tramway, since the collector, which replaces the gripper, is not used to transmit a mechanical force. If the tube containing the electric main were placed under one of the rails of an ordinary tramway—and by preference, under the rail on the 'near' side, or under the two outer rails on a double line—and the slot were to open into, and in fact form, the groove of that rail, we should have all the things really essential to an electric tramway, and we should only have the surface of the street cut up by two rails for each line instead of by three. The rail would have to be strong enough to carry the tramcar, and the type of construction used at Blackpool would not be suitable; but there should be no difficulty in designing a rail that should be strong enough vertically to carry loaded cars without sensible deflection, and stiff enough laterally to support the paving setts, and maintain the proper width of the slot."

THE INDIAN AND COLONIAL EXHIBITION.

ON Tuesday last, May 4th, the Indian and Colonial Exhibition was opened by a most imposing State ceremonial, the Queen, the Prince and Princess of Wales, and many other members of the Royal family being present, attended by a large number of high dignitaries of Church and State, Indian and Colonial representatives, and others. The aspect of the whole place is changed since the close of the last show, every colour and every degree and style of decoration appearing to have had free play, the result giving a most striking air of novelty and comprehensiveness. The Inventions Exhibition having worn a somewhat sombre and matter of fact aspect, the contrast is all the more remarkable. The electric lighting continues to be one of the attractions, and was in full operation on the opening night, but the old arrangements are altered to a considerable extent. In the electric light shed a great clearance has been made, the only companies now in possession being the Anglo-American Brush Corporation, Messrs. R. E. Crompton & Co., the Pilsen-Joel, and the Edison and Swan. Altogether, there are about 30 machines of various types in the shed, driven, as on former occasions, by the engines of Messrs. Davey, Paxman & Co. But, in addition to the machinery in this building, Messrs. Galloway and Sons have in a shed specially allotted to them two of their powerful horizontal engines, driving four large Elwell-Parker dynamos. These are for the lighting of the gardens and fountains, which last year was undertaken by Messrs. Siemens. The lighting of the dining room by Edison-Swan lamps, under pink shades, is much admired, and the substitution of arc for incandescent lighting through the large galleries is, on the whole, an improvement. A small building has been put up in the South Promenade to accommodate storage batteries of the Electrical Power Storage Company, for the lighting of the Subway, the Club Dining Room, and some other departments. The number of arc lights this year is about 400—namely, 160 Brush, 140 Crompton, and 100 Pilsen.

NOTES.

Temporary Electric Lighting.—The electric lighting at the festivities at the Duke of Newcastle's Clumber estate, held in honour of the coming of age of the Duke, was carried out by Blakey, Emmott & Co., of Halifax. Judging from the reports in our daily contemporaries the electric light added greatly to the enjoyment of the visitors to Clumber. In the ball-room, which accommodates 600 guests, some very elaborate chandeliers were ranged down the centre of the room, and supplied with incandescent lamps; along the sides of the room on each side, and over the various mirrors drop pendants and brackets were freely distributed. A large candelabra in the drawing-room carried 30 lights, while the smaller rooms were also lighted. Ranged about the mansion outside and at the stables, &c., were a number of Pilsen arc lamps and on the top of the mansion was fixed a search light of 6,000 candle-power, so arranged that its rays could be directed in any direction over the vast estate. The dynamos consisted of five Blakey-Emmott machines, driven by a Marshall's engine. We congratulate Messrs. Blakey-Emmott on the manner in which they carried out the work.

The silver wedding of Lord and Lady Revelstoke at Membland, Revelstoke, was celebrated, among other festivities, by a ball in a large tent in the grounds, which was brilliantly illuminated by numerous incandescent electric lamps.

The Electric Light at Sea.—Lord Alfred Churchill recommends that the electric search light now in use on war-ships should be kept at work at night by all passenger steamers on much frequented routes. The cost could not be great; but were it ten times more than it is likely to be, it is considered that it would be amply repaid by the security which this beneficent invention would give to all who travel by sea.

Mr. Bernstein's Paper on Glow Lamps.—The Bernstein Electric Lamp Company informs us that there were several inaccuracies in our report of Mr. Bernstein's reply to the remarks made during the discussion on his paper upon "Low Resistance Glow Lamps," and offers to send us a correct copy of Mr. Bernstein's reply; this we should be glad to receive.

Too Much Light on Brooklyn Bridge.—The beautiful arch of electric lights upon the Brooklyn Bridge has, from the beginning, it is alleged, given offence to the pilots of the river craft, who maintain that the great brilliancy blinds them and renders the lights of vessels indistinct. Recently a maritime journal drew attention anew to the subject, and asserted that not until a collision occurs will the evil be remedied. These opinions from parties who have no ill-will toward the electric light, says the *Electrical World*, deserve consideration, and if the lights are a source of danger steps should be taken to render them harmless to the sailing fraternity. A very simple remedy is at hand, which, although it may detract from the beauty of the scene, would nevertheless be effective. The remedy lies in merely enclosing the lamps in hoods or screens so that their light should only be shed upon the bridge, cutting off their rays in all other directions.

The Newspapers and the Electric Light.—The *Citizen*, the other day, committed itself, as many other newspapers have done, when discussing electric light matters. Mr. A. L. Fyfe has given our contemporary some slight information on points regarding which it was evidently in the dark, and possibly it may now believe that the prospects of the electric lighting industry are a little brighter than it had imagined.

Electric Lighting of a New College.—Messrs. B. Verity & Sons have obtained the contract for lighting the new Holloway College, at Egham, which is to be opened by the Queen in June. Over 500 16-C.P. lamps are being installed. The current will be generated by two Edison new form dynamos, each of 500 light capacity.

The Portsmouth Telephone Exchange.—A tribute to the value of this exchange was fittingly rendered at the last meeting of the Chamber of Commerce, which includes in its membership the most important business men of the town. The Hon. Secretary, Mr. W. Edmonds, stated that the system had now been in operation for about twelve months, and 64 subscribers were connected. Commercially speaking its value could not be over rated. He understood that it was contemplated that they would shortly have depôts established in different parts of the borough for the convenience of subscribers.

Telephone Extension in Scotland.—The National Telephone Company has resolved to proceed with the erection of trunk lines from Dundee to Glasgow, with branches to Edinburgh, &c.

Underground Telephone Wires.—The Bell Telephone Company's report shows that 2,203 miles of telephone wire were put under ground last year in the cities of Washington, Chicago, New York, Pittsburg, Boston, Brooklyn, Baltimore, and Milwaukee. There are now 3,428 miles of wire under ground in these cities, the amount being proportioned not to the size of the cities so much as to the amount of pressure put upon the companies for the abatement of the overhead wire nuisance.

An Arrest by Means of the Telephone.—Shortly before four o'clock on Thursday morning, last week, a housekeeper on the premises occupied by Messrs. Bennett and Roach, Queen Square, Bristol, called the attention of the telephone operator to the fact that there were burglars in the house. The operator immediately communicated by telephone with an officer at the sessional court-house in Bridewell Street, and explained the singular nature of the message which he had received. He was informed that assistance would be sent without delay, and, about an hour after, an inquiry by telephone received the welcome reply that the constables who had been despatched to Queen Square had succeeded in making an arrest. The burglar was sentenced to three months' imprisonment.

The Telephone and Lightships.—At a meeting of the Ramsgate Town Council held the other day, the question of taking steps to establish telephonic communications between lightships on the Goodwin Sands and that town, was discussed. It was decided to let the matter stand over until after a meeting which is shortly to be held, and which will be addressed by Colonel King-Harman, M.P., has taken place, and then a deputation is to be formed to wait upon Mr. Mundella, the President of the Board of Trade.

Telegraph Revenue.—The receipts on the telegraph service from April 1st to May 1st, 1886, amounted to £135,000, against £140,000 received from April 1st to May 2nd, 1885.

Why the Commercial Cable Thrives.—The following letter which appeared in the *Times* City article, refers to the struggle between the Atlantic Cable "pool" and the Mackay-Bennett Company:—"I see it stated in some newspapers that one of the reasons for the cut in cable rates is the allowance by the Mackay-Bennett Cable of rebates to large customers. I think this accusation is not justified by the facts. Apart from certain advantages that a cable running right into New York city possesses, there are thousands in that city who will go out of their way to benefit any enterprise that is run in opposition to Jay Gould and his clique. Actuated by both the above considerations, I some time ago requested all my firm's correspondents who were in the habit of cabling us to give the preference to the Mackay-Bennett cable. They have done so, and, as our cables sometimes cost $100 a day, we may be supposed to receive a rebate. This we have never received, have never asked for, and never expect to receive the offer of.—NEW YORKER."

German Cable Charges.—The German Postmaster-General announces that from May 5th the charge for all telegrams sent from Germany to all the more important centres of the United States and Canada by the German cable, *viâ* Emden and Valencia Island, will be reduced until further notice from 1 m. 65 pf. to 65 pf. a word—a reduction of 1 m., or 1s., on each word. At the same time a corresponding reduction of charge will be made for telegrams to Mexico, as well as to Central and South America.

Cable Rates to South America.—The Eastern Telegraph Company, Limited, notifies that by arrangement with the Brazilian Submarine Telegraph Company, Limited, the rates to South America will, on and after 5th inst., be materially reduced. The reductions vary from 2s. to 3s. per word.

A New Light.—A general meeting of the Philosophical Society of Glasgow was held last Wednesday week in the rooms of the society, Bath Street, Dr. Henry Muirhead, president, in the chair. Mr. J. B. Hannay, F.R.S.E., described a new industrial light. He explained that it was produced by burning natural mineral oil, the product from gas works, or the oil from blast furnaces or coke ovens under pressure, in the form of a jet of spray, or in conjunction with heated air or, where procurable, dry steam. The flame had an illuminating power of 2,600 candles, and was useful for the illumination of large open air space or workshops. A one horse-power air compressor would supply power for eight lamps, giving 20,000 candle-power, or an eighth of a horse-power for each lamp. The original cost of the appliances was calculated to be about one-fourth of that necessary for the production of the electric light, which it was found to surpass for industrial purposes, as it did not cast such strong shadows. In the course of a discussion which followed, Mr. Foulis, manager of the Glasgow Corporation Gas Works, said there was no doubt that the new lamp would have a very great future. Mr. Hannay exhibited specimens of the appliances by which the light is produced, and showed one of the lamps burning in the lane behind the Philosophical Society's building.

Weston System of Domestic Lighting.—On the 21st ult., Mr. Hugh Watt, M.P., Chairman of the Maxim-Weston Electric Company, received a number of the shareholders and other gentlemen at his private residence for the purpose of exhibiting and explaining the new Weston system of incandescent lighting. Throughout the principal rooms of the house there are 30 incandescent lamps; the dynamo and a 2½ horse-power gas engine being located in a small outhouse in the basement. As an illustration of what may be done in a town house where there is not much spare room, the installation is an interesting one, and the light during the evening referred to was fairly steady and satisfactory.

The Electric Tramway on Ryde Pier.—Very satisfactory accounts reach us of the working of the electric tramway, which was a short time since established on Ryde Pier by Messrs. Siemens & Co. On grounds of economy, speed, and comfort, it has more than realised the anticipations of the directors, who, in spite of a somewhat vigorous opposition, were wise enough in the first instance to advocate electricity, as opposed to other motive powers. During the Easter holidays there were as usual a large number of visitors to Ryde, and the novelty of a tramway propelled by an "unseen force" proved a great source of attraction.

Electrical Staffs for the Dockyards.—The action of the Admiralty in directing fitters from other dockyards to be sent to Portsmouth for instruction in electricity, would appear to point to an intention—long since expected—on the part of the authorities of giving as little of their work as possible to private electrical firms. Of course, the numerical strength of the present dockyard electrical staffs would not be sufficient to enable them to carry out the work of fitting large vessels with the electric light, but they must rather be considered as a nucleus for future enlargement. It is not certain that firms like Messrs. Siemens would be much the losers were the work of fitting vessels of the Royal Navy taken out of their hands entirely. They would still have to supply the the apparatus; and, after all, that is the most lucrative part of the business.

Electricity in the Navy.—The *Scout* at Portsmouth is shortly to be fitted with the electric light, the dockyard authorities having been directed to forward to the Admiralty an estimate of the cost for carrying out the same. Last week successful trials of the electric light were made on board the *Phæton* in the Medway. Early next month the *Phæton* is to leave Chatham. Some experiments with the Ericsson submarine gun are shortly to take place at Portland, under the supervision of Lieut. Gladstone, who visited the inventor when on the North American station. A platform is being erected for the gun, which will be so placed as to be dry and easy of access at low tide, and be covered with 10 or 12 feet of water during two or three hours of each other tide, when the experiments will be carried out.

An Electric Clock.—The work of fitting the electric clock at Mount Wise, by which the circuit will be "closed" direct from Greenwich and the one o'clock gun thus fired punctually, is being hastened as far as possible, under the direction of the Devonport Dockyard authorities. It is proposed to make considerable use of the new appliance. By arrangement with the Admiralty and Board of Trade, not only ships of war, but also merchantmen will be able to get Greenwich time on arriving in the Sound, by signalling for that purpose. This will be a great boon.

Sudden Death.—On Friday night last, at the office of the National Telephone Company in St. Andrew Square, Edinburgh, Mr. W. D. Chaffers, who was in the employment of the company, dropped down dead. He had been seized by a bleeding at the ear, and died shortly afterwards; the cause of death being hemorrhage of the lungs.

The German Edison Company for Applied Electricity.—At the annual meeting of this company, held April 29th, the report presented speaks of considerable progress. The balance sheet shows a clear profit of 380,481 marks, 37 pfennigs, or in round numbers, £19,024. From this sum 110,000 marks are deducted for an extraordinary reserve fund, and 250,000 are divided among the shareholders, being five per cent. on the capital of 5 million marks. During the course of 1885, 129 machines for 22,000 glow lamps and 500 arc lamps have been installed on the company's system. This is a notable advance on the year 1884, in which only 13,000 glow lamps were put up. In addition certain licensees of the company, including the firm of Siemens and Halske, have installed 13,000 lamps. The electric light has been introduced in the theatres of Stuttgart, Munich and Berlin, and is about to be adopted in those of Schverin and Dessau. The company has entered into an arrangement with the Prussian Department of Education to light up the University of Berlin.

Prof. Hughes on Self-Induction.—There was a misprint in Mr. James Swinburne's letter in our last week's issue, "$f\,t\,d\,e = f\,t\,d\,e'$" should have been "$f\,t\,d\,e = f\,t\,d\,e'$."

Gas v. Electricity.—At the ordinary meeting of the Institution of Civil Engineers on Tuesday last a paper on "The Mersey Railway," by Mr. Francis Fox, M.I.C.E., was read. In it the writer says:—"The stations were lighted with gas, as the author was of opinion that, so long as the smallest uncertainty existed as regarded the regularity of electric lighting, a railway company was not justified in employing electricity as a lighting agent, unless gas was also laid on, so as to be readily available in case of break down of the electric lighting machinery."

An Electric Launch Trial Trip.—On Wednesday last the final trial trip of the launch, which we speak of at length in our other columns, took place. The test was over the measured mile at Greenhithe, at the same speeds as mentioned on p. 423. The representative of the Italian Government was present, and declared himself to the effect that the results exceeded his greatest anticipations. The launch is now awaiting shipment to its destination, and we heartily congratulate Mr. Reckenzaun on the success he has so far achieved in this branch of electrical engineering, which we hope may rapidly develop under his fostering care.

Messrs. Yarrow & Co., who constructed the hull, and Messrs. Stephens, Smith & Co., the engineers who built and fitted the Reckenzaun apparatus to her, must also experience considerable pleasure at so successful a termination to their labours. We must not forget to add that the secondary batteries were supplied by the Electrical Power Storage Company.

The Society of Telegraph Engineers and Electricians.—The next meeting at 25, Great George Street, S.W., will take place on Thursday, May 13th, 1886, at 8 p.m., when a paper on "Long Distance Telephony," by W. H. Preece, F.R.S., past president, will be read.

Death of the Maker of the First Telegraph Instrument.—The *Telegraphist* announces that the veteran mechanic, Mr. John Brittan, who made the first telegraph instrument, contrived by the late Sir William Fothergill Cooke, died at Luther Cottage, Odd Down, Bath, on February 2nd, 1886, in the 76th year of his age.

The "Great Eastern."—This famous ship left Milford Haven for Liverpool last week. Those on board had an adventurous journey, as the engine broke down for a time, and, later, an alarm of fire was raised. The outbreak did not prove serious, and was soon subdued. The *Great Eastern* will remain in the Mersey during the Maritime Exhibition, and will afterwards, it is stated, be used as a coal hulk.

The Journal of the Society of Telegraph-Engineers.—The following are the contents of No. 60 of the journal of this society, which has just been issued :—Inaugural Address of the President (Prof. Hughes); discussion on the address. Original Communication :—"A simple method of preventing the inconvenience caused by the acid vapour carried into the air when hydrogen gas is evolved from acidulated water," by F. Higgins. Abstracts :—"Theory of the electromagnetic telephone receiver," by E. Mercadier; "The transformers of Blathy, Deri, and Zipernowski," by W. C. Buhniewski; "Electric and thermic properties of saline solution," by J. Moser; "The source of ordinary atmospheric electricity," by Sohncke; "Experimental researches on the specific inductive capacity of some gases and vapours," by J. Klemencic; "On the discovery of Mr. Fritt's of the electromotive action of illuminated selenium," by W. Siemens; "Peltier's phenomenon in liquids," by E. Nacarri and A. Bartelli; "Underground cables of the Nuremburg telephone system," by E. Bieringer; "Explanation of the differences between Frölich's theory of the dynamo and his own," by R. Clausius; "Results of the magnetical and meteorogical observations made at the Royal Observatory, Greenwich, in the year 1883," by Wm. Ellis, F.R.A.S. At the end of the number is a list of articles appearing in the principal foreign technical journals.

The Edinburgh International Exhibition.—The opening ceremony in connection with this exhibition was announced for yesterday (Thursday), in the presence of Prince Albert Victor. In the open court between the two northern sections the Post Office is situated, and here the whole branches of postal, telegraph, and money order business will be conducted.

For lighting purposes, the exhibition has been divided into six sections, every one of which, with one exception, is to be served by a different firm of contractors. In the main avenue there are 1,444 incandescent lamps of 20 candle-power each. Messrs. King, Brown & Co., Rosebank, Edinburgh, show fourteen dynamos, driven by four vertical engines, by Marshall, of Gainsborough. These dynamos provide the 1,400 incandescent lights in the central court and 1,200 in the grounds outside. The Thomson-Houston system is worked by Mr. Richard Miller, Glasgow, who has seven dynamos, four of which supply the permanent building with 67 arc lamps, two the north-west court with 80 lamps, and the other is for the outside illumination of the main entrance. These dynamos are driven by two of Robey's engines, of 30 and 40 horse-power respectively. The Gulcher Company has four dynamos supplying 32 arc lamps in the south-west courts, and the incandescent lamps in the reception rooms and offices in the permanent pavilion. The coupling switches of this system are so arranged that, should any circuit break down, the machine can be cut out and one of the others put on. The Anglo-American Brush Corporation has four dynamos for 55 arc lights in the north section, and they have also two Victoria machines for lighting Old Edinburgh with 250 incandescent lamps. Messrs. Andrews & Co., Glasgow, have the largest dynamo in the exhibition, weighing over five tons, and it provides for 33 arc lamps. They have a second dynamo, which they are keeping in reserve in case of accident. The permanent building will be lighted with 150 arc lamps, and in front of the main entrance there will be other six arc lamps. On the northern promenade there will be 32 arc lamps, each of 2,000 C.P., and suspended from eight masts 50 feet in height. Old Edinburgh will be illuminated by 250 incandescent lamps; and in the machinery section there will be 32 arc lamps of 2,000 C.P. each. In all, there will be about 3,150 lamps, giving a light of 570,000 C.P. The grand hall and picture galleries will be bathed in a flood of light equal to that of 130,000 candles, and the central court will enjoy a light equal to that of nearly 29,000 candles.

The electric railway has been laid down along the northern promenade, and two fine cars have been supplied for it, free of charge, by the North Metropolitan Tramway Company, London.

The Crompton Dynamo Tests.—There are several points in the letter of Mr. Sidney F. Walker which deserve attention. We begin to doubt whether any good purpose has been served by the publication of these tests, which appear to be more or less meaningless. We found several weak points in the report, but Mr. Walker goes further still, and proceeds to demolish it almost entirely.

The Strange History of a Dynamo.—We are requested to inform a "South Hackney Correspondent" that the commutator illustrated last week was intended as a typical representation, and that such machines as those of Pixii or Clarke are of no use for the purpose he mentions. We imagine that Messrs. J. and E. Dale could supply our correspondent's requirements.

Dr. Stone's Lectures.—In this issue the Lumleian lectures of Dr. Stone come to a conclusion. The perusal of these must have been specially interesting to both electricians and medical men, for the author has gone more deeply into his subject than has hitherto been done.

Winding Magnets for Dynamos.—We publish this week the fourth paper of Mr. Carl Hering on winding magnets for shunt, series and compound machines. These articles, as our readers are already aware, have been appearing in the recent numbers of our esteemed contemporary the New York *Electrical World*.

The Blackpool Electrical Tramway.—"A Borough Surveyor," in his comments upon the construction of Mr. Holroyd Smith's Blackpool line, suggests that the conductor should be placed beneath one of the rails, the current collector passing through the groove between the two portions of the rail. In a paper on the "Electrical Propulsion of Vehicles," published in the April number of the *Bulletin de la Société Internationale des Electriciens*, we find the above suggestion has been carried out in the system of M. Berlier. Those interested in this very important application of electricity should read the article to which we refer.

City and Guilds of London Institute.—At the Central Institution, Exhibition Road, Professor Ayrton continues his course of lectures on "Some of the Industrial Applications of Electricity," on Friday week, May 14th, at 5 p.m. The subjects for May 14th and 21st are "The Electric Transmission of Power," and on May 28th "Electric Locomotion." The following gives the subjects more in detail :—May 14th and 21st, "Electric Transmission of Power." Waste of power in the conductors; advantages and disadvantages of the parallel system of supplying electric power; economy effected by the use of the series, or the parallel-series system; most economical size of conductors; heating of conductors; uniform potential difference, or uniform current, along the mains; use of accumulators, secondary generators and motor-dynamos, in electric transmission of power; practical results already obtained with electric transmission; comparison of electric with hydraulic and wire-rope transmission of power. May 28th, "Electric Locomotion." Tramcars carrying a store of electric energy; electric launches; methods of conveying electric power to moving vehicles; electric, steam, horse, and wire-rope traction; absolute blocking with electric railways; telpherage. Probable future developments in the applications of electricity. The number of students attending the course is about 80.

Magnetising Watches.—Mr. J. Jerritt, A.S.T.E. & E., writing from Plymouth, says :—"Will any of your scientific readers kindly inform me whether they consider the magnets in magnetic appliances—such as a belt or chest protector—sufficiently powerful to magnetise an ordinary watch?"

Electric Locomotion.—Mr. A. J. Jarman writes to us, too late, however, for our correspondence columns, as follows:—"I notice in your last issue of the ELECTRICAL REVIEW that a trial trip has been made with one of the electric locomotives of the Electric Locomotive and Power Company, but it does not state the number of passengers upon and in the car, nor the amount of electrical energy employed to *start* and to keep in motion both the car and locomotive. I believe that it was by my advice, when I was the manager to the late Jarman Electrical Company that Elieson's plan of transmission was tried. It was also the suggestion of the late Dr. Stephen Monckton, of Maidstone, to convert this mechanism into a locomotive. While the electro-motor itself is the design of an electrical engineer, whose name deserves to be better known than it is, because of his sound, practical and mathematical knowledge in connection with electricity; I allude to Mr. Fredk. Walker, of Tottenham, I notice that your account states that *the engine carried* 70 *cells*. Was this all? When the trial was *first* made at the works at Homerton it required 13 cells to *set the locomotive and its mechanism alone in motion*. I would venture to say that if the whole of the facts were known that with a half loaded car it would require not less than 130 ampères at 150 volts to start. I am convinced that with this locomotive the energy of 13 storage cells at the least is wasted upon the locomotive itself and consequently the cost of those 13 cells also. I think the thanks of all your readers are due to Mr. Reckenzaun, who has pointed out in such a very clear and straightforward manner the essential points to be considered in the application of electricity to locomotion. With regard to the various plans of transmission I have had some experience with Mr. F. H. Danchell's plan by friction, and also by radial toothed gearing, but I am of opinion that neither of these plans are the best adapted for the purpose. I know that by the latter plan when a test was made it took 17¾ electrical H.P. to develop 4 H.P. upon the driving axle. I am sure that very many of your readers besides myself would like to know more about the success of this locomotive (not financially, for this is assured, at least to one section of the company) in comparison with the cost of propulsion by horses, for I am quite confident that if this electric locomotive can be made to compete in save of cost compared with horses, success *must* attend a good sound and efficient plan that can be applied to the car *itself*, and thus do away with the locomotive, its cumbrous mechanism, and useless weight."

The Oppermann Failure.—The public examination of C. T. J. Oppermann, twice adjourned, was continued at the Bankruptcy Court yesterday (Thursday) before Mr. Registrar Hazlitt. In reply to Mr. Cooper-Willis, who appeared for the trustees, the bankrupt stated that he was now in the employ of his brother, a minor, who was engaged in a business somewhat similar to that which he (the bankrupt) had previously conducted. His brother managed the business, and paid him £3 weekly. He did not keep his brother's books, nor did he know anything of his affairs. The bankrupt was not discharged, but the examination was adjourned *sine die*, as the brother who was a partner in the business and lived in Chicago, carrying on a branch there, had not surrendered to the Court.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Western Counties and South Wales Telephone Company, Limited.—The annual return of this company, made up to the 8th ult., was filed on the 30th ult. The nominal capital is £400,000 divided into 20,000 preference shares of £5 each and 300,000 ordinary shares of £1 each. The shares taken up are 10,000 preference and 275,000 ordinary. Upon 6,600 preference shares £2 per share has been called, and £5 is considered as called upon 3,400 shares, and the full amount is considered as called upon each of the 275,000 ordinary shares. The calls paid (including £898 paid in advance of calls and £10 on forfeited shares), amount to £13,828, leaving £280 unpaid.

An extraordinary general meeting of the company was held on the 25th March, when resolutions were passed altering the articles of association to enable the company to borrow money, but so that not more than £6,000 be owing at any time without the consent of general meeting and providing that not more than £2,000 of such money be borrowed without the consent of the United Telephone Company, Limited, nor without such consent to carry more than 6 per cent. per annum interest. It was also resolved that the directors appoint the remuneration of the first auditors, and that the company in general meeting shall fix the remuneration of subsequent auditors. These resolutions were confirmed on the 14th ult., and duly filed on the 30th ult.

NEW COMPANY REGISTERED.

Hydrogen Amalgam Company, Limited.—Capital, £200,000 in £1 shares. Objects: To enter into agreements to purchase and deal with mineral, chemical, and electrical properties and inventions of every description. Signatories (with one share each): *J. G. Johnson, 23, Cross Street, Finsbury; *B. C. Molloy, M.P., 3, Elm Court, Temple; *F. W. Browne, 30, Wood Street, E.C.; C. Colladon, Twickenham; S. W. Spratt, 43, Queen Victoria Street; A. Brogdon, J.P., 9, Victoria Chambers, S.W.; T. Wakefield, Croydon; J. C. Castro, M.D., Torquay. Directors' qualification, 200 shares; the signatories denoted by an asterisk are the first directors. Registered 4th inst. by Messrs. Smiles & Co., 15, Bedford Row.

CITY NOTES, REPORTS, MEETINGS, &c.

The Brazilian Submarine Telegraph Company, Limited.

THE Report of the directors for the half-year ended 31st December, 1885, states that the revenue for this period amounted to £77,066 0s. 10d., and the working expenses to £12,893 5s. 5d. After providing £9,680 for debenture interest and sinking fund, and £1,199 15s. 4d. for income tax, there remains a balance of £53,293 0s. 1d.; to this is added £2,830 16s. 3d., brought forward from 30th June last, making a total of £56,123 16s. 4d. First and second interim dividends amounting to £39,000 have been paid, and £15,000 transferred to the reserve fund, leaving the sum of £2,123 16s. 4d. to be carried to the next account.

The message receipts for the half-year amounted to £76,825, which shows a decrease of £12,178 when compared with the receipts for the corresponding period of 1884. This large decrease has been caused principally by the depressed state of trade and the decline in the rate of exchange. With respect to the latter, the directors are glad to report there is now a marked improvement in the exchange value of the Milrei.

All the company's cables are in good working order.

Acting under the authority given by the shareholders to the Board at the extraordinary general meeting held 21st January last, this company has joined with the Eastern Telegraph Company, and the Telegraph Construction and Maintenance Company, in the formation of the African Direct Telegraph Company. That company's cable from St. Vincent to Bathurst, on the African coast, is already laid, and will shortly be ready for traffic; the other cables are in a forward condition of manufacture, and it is expected that they will be laid and in operation during the present summer. The interest of the Brazilian Company in the telegraphic communication with the West Coast of Africa is very important. The line will be worked at St. Vincent in this company's station, and it is agreed the telegrams between England and Africa for and from the African Direct Telegraph Company's system shall be conveyed by the cables of the Brazilian Company between St. Vincent and Lisbon, and by those of the Eastern Company between Lisbon and London.

Submarine Cables Trust.

THE report of the trustees for the financial year, to April 15th, 1886, states that the revenue for this period, including the balance brought from the previous accounts, viz., £1,949 16s. 8d.

and including the dividend on the Eastern Extension shares referred to in the last report of £2,987 11s., amounted to £23,776 5s, 6d. The expenses of the Trust for the twelve months amounted to £1,349 14s. 10d. The payment of two half-yearly coupons at the rate of 6 per cent. per annum absorbed the sum of £20,286, leaving a balance of £2,140 10s. 8d. to be carried forward. The decrease of revenue this year has been entirely owing to the diminished dividend paid by the Anglo-American Company, in consequence of the competition with the Commercial Cable Company. The securities held by the trustees remain unchanged. Particulars of the original and present investments of the Trust are given as usual in the table which follows this report.

India Rubber, Gutta Percha, and Telegraph Works Company, Limited.—A settling day and quotation have been appointed by the Stock Exchange Committee for the £200,000 4½ per cent. debentures of this company.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of April was 5,961, estimated to produce £3,300, against 4,319 messages, producing £3,886 in the corresponding month of last year. The receipts for the month of January, estimated at £2,850, realised £2,891.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 30th April are £2,435, as compared with £3,857 in the corresponding period of 1885. The January receipts, estimated at £5,484, realised £5,477.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 30th were £2,551, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for April, 1886, were £19,800; from January 1st to April 30th, 1886, £78,480; in the corresponding months, 1885, £80,200; and of 1884, £81,640.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of April were £1,597, against £1,510 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for April amounted to £47,611, against £63,085 for the corresponding period of 1885.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending April 30th, were £3,225.

NEW PATENTS—1886.

5817. "Galvanic batteries." S. F. WALKER. Dated April 29.

5823. "Telephone receivers." J. L. CORBETT. Dated April 29.

5824. "Telephone transmitters." J. L. CORBETT. Dated April 29.

5825. "Telephonic apparatus." J. L. CORBETT. Dated April 29.

5839. "Transforming or converting electrical energy; apparatus therefor." E. CONEY. Dated April 29.

5855. "Galvanic battery." F. W. BRANSON. Dated April 30.

5878. "Automatic electric switch for controlling the current passing between the generator and secondary batteries, and for cutting out lamps, &c." J. RADCLIFFE. Dated April 30.

5884. "Thermopiles." H. W. COOK. Dated April 30.

5932. "Running and burning work of a magnesium lamp with electrical self-winding up." H. HEINE and SOHN. Dated May 1.

5940. "Telephones." P. GANNON. Dated May 1.

5962. "Incandescent electric lamps." T. J. HANDFORD. (Communicated by E. H. Johnson.) Dated May 3.

5971. "Electrical batteries and appliances." A. W. ARMSTRONG. Dated May 3.

5979. "Incandescent electric lamps." B. J. B. MILLS. (Communicated by W. Holzer.) Dated May 3.

5985. "Applying electricity to illuminative and other purposes in theatrical and analogous representations." MARY MCMULLIN. Dated May 3.

5993. "Electro-magnetic retouching pencils for photographic purposes." H. J. HADDAN. (Communicated by L. Fried and B. Iscovits.) Dated May 3.

6027. "Recording and reproducing speech and other sounds." J. Y. JOHNSON. (Communicated by the Volta Graphophone Company.) Dated May 4. (*Complete.*)

6035. "Receivers, apparatus and circuits for telephone communication." A. J. BOULT. (Communicated by W. Marshall.) Dated May 4. (*Complete.*)

6042. "Reproducing sounds from phonographic records." J. Y. JOHNSON. (Communicated by the Volta Graphophone Company.) Dated May 4. (*Complete.*)

6044. "Magnetophones." F. H. BROWN. Dated May 4. (*Complete.*)

6047. "Reproducing speech and other sounds by means of records." J. Y. JOHNSON. (Communicated by the Volta Graphophone Company.) Dated May 4. (*Complete.*)

6062. "Transmitting and recording sounds by means of radiant energy and means and apparatus therefor." J. Y. JOHNSON. (Communicated by the Volta Graphophone Company.) Dated May 4. (*Complete.*)

6075. "Galvanic batteries." A. Héguilus. Dated May 4.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

3467. "Improvements in dynamo-electric machines." A. M. CLARK. (Communicated from abroad by L. Vissière, of Marseilles.) Dated March 17. 11d. Has for its object an economical mode of construction whereby to utilise, under the most favourable conditions, the material employed and obtained from the mass the maximum effect, regard being had to the different strains which they have to support.

3805. "Electric governors." J. SWINBURNE. Dated March 24. 6d. According to this invention a dynamo-electric machine is controlled as to electromotive force or as to current by altering the current round the field magnets, or by altering the speed of the driving engine, or the electromotive force on any particular part of a circuit is regulated, as when a batch of glow lamps is to be kept under uniform electromotive force when they are as a batch in series with arc lamps or with other batches of glow lamps. Thus if a direct current machine is wanted to give a constant electromotive force or pressure with a varying load, and perhaps a badly-governed driving engine; suppose the machine to be shunt-wound, the field magnet coils are put in circuit with a liquid resistance which admits of a gradual alteration. The resistance can be made by so arranging platinum or lead plates in dilute acid that the resistance of the route the electricity takes going from one to the other can easily be varied within wide limits. The plates may themselves be movable and may be separated or brought nearer each other, or they may be stationary while the conducting path between them is altered by the interposition of some insulator. A simple way is to make one electrode a rod and the other a hollow cylinder round it, and to allow a tube of xylonite, celluloid, or glass to be brought up between them to increase the resistance.

3942. "Electric measuring instruments." J. SWINBURNE and S. EVERSHED. Dated March 27. 6d. To make an instrument according to the invention coils may be used as in the instrument well known as Weber's dynamometer, where the current in a fixed coil acts on a movable coil also with current, so that the current or currents may be measured by measuring the force or forces acting on the movable coil. The force tending to move the movable coil may be opposed by the force of gravity. Thus the movable coil may be mounted on an arbor whose axis is not vertical, and the centre of gravity of the system may be arranged so as not to be in the axis of the pivot.

4286. "Improvements in or connected with moderators for electric lamps." E. L. ROUSSY. Dated April 7. 8d. Relates chiefly to a current regulator consisting of carbon powder which is compressed by a screw, previously described in the REVIEW.

4468. "Improvements in electric railway systems." T. J. HANDFORD. (Communicated from abroad by F. J. Sprague, of New York.) Dated April 10. 8d. The object of the invention is to produce an economical and efficient system for utilising electricity as the motive power in railways; and the invention consists in the various novel arrangements and devices employed in accomplishing the above-named object.

15701. "Improvements in the insulation of electric aerial line wires." A. E. GILBERT. Dated December 21. 6d. Has reference to a new shackle insulator.

1886.

154. "Improvements in dynamo-electric machines and electric motors." H. J. ALLISON. (Communicated from abroad by Elihu Thomson, of America.) Dated January 5. 8d. The principal object of the invention is to secure a simple and efficient dynamo-electric machine adapted to furnish a constant potential, or nearly so, and an electric motor for the purpose of maintaining, when fed by a current of constant potential, a nearly constant speed.

337. "Improvements relating to the electrical transmission of sound." W. R. LAKE. (Communicated from abroad by J. W. Bonta, of America.) Dated January 8. 8d. Consists in transmitting vocal articulations and other sounds over a line or secondary circuit by electric currents induced by varying, as well as breaking, the contact between two electrodes in the primary circuit associated with the said secondary circuit.

993. "An apparatus consisting of a combination of an electric alarm bell attachment to a hook or peg, or hooks or pegs, used for hanging or suspending goods or other articles." S. P. WESTON. Dated January 22. 4d. Consists of an apparatus consisting of a combination of an electric alarm bell attachment, so adjusted to a hook or peg, or hooks or pegs, used for hanging or suspending goods or other articles so arranged that when any such goods or articles are displaced or removed, an electric contact is made which closes an electric circuit in which an electric bell and battery are placed, thus giving an alarm by ringing the bell.

1151. "Improvements in galvanic batteries." W. W. POPPLEWELL. (Communicated from abroad by F La Otis Lathrop, J. W. Carter, and C. Faber, all of New York.) Dated January 26. 8d. The invention consists of a metallic jar or cell, that is lined at the interior with rubber or other acid-resisting material, said rubber lining being extended over the edge of the jar, of a porous cup provided with enlarged rounded ends and parallel sides that

approach closely to each other, a zinc made in the form of a screw with one or more threads, and provided with a depression or pocket at its top part that communicates by a hole with the screw thread. so as to supply the mercury for amalgamating the zinc while in use, and without removing it from the jar, and of carbons made in the form of plates, and provided with conical or diamond-shaped projections or teats at both sides.

1161. "A new or improved lining for the walls of electric furnaces." W. P. THOMPSON. (Communicated from abroad by E. H. Cowles and A. H. Cowles, both of America.) Dated January 26. 6d. Relates to the apparatus described in the No. of the REVIEW for February 26th, 1886.

1310. "Improvement in telephone transmitters." W. P. THOMPSON. (Communicated from abroad by E. T. Gilliland, of America.) Dated January 29. 8d. Relates particularly to the form and construction of the containing chamber for carbon granulations; to the special form and relations of the electrodes; to the combination with the said electrodes of the said granular mass of low conducting material; and to the particular form of support or adjustable fixture devised for the transmitter proper; and, finally, to the form of air passage or speaking tube by which the sound waves are directed upon the diaphragm.

1354. "An improved electrode for secondary batteries." H. J. ALLISON. (Communicated from abroad by E. M. Gardner, of America.) Dated January 30. 6d. Consists in a new construction of the metal frame work or retaining plate, and in a new composition which is inserted in and supported by said plate. The composition consists of equal parts of pulverised carbon and lead oxide (red) intimately mixed. To three parts of this mixture is added one part of calcined magnesia. Dilute hydrochloric acid is then added in the proportion of one part acid to four parts water, and the resulting pasty mass is packed into cavities in the plate.

2403. "Improvements for operating electric smelting furnaces." H. J. HADDAN. (Communicated from abroad by E. H. Cowles and A. H. Cowles, both of America.) Dated February 18. 8d. This invention relates to improvements for operating electric smelting furnaces, in which an ampèremeter and resistance box are respectively connected in the circuit between the dynamo and the furnace, to the end that, by means of the ampèremeter, the strength of the current passing through the furnace is indicated, whereby is made known the resultant effect inside the furnace, so that the latter may be properly charged and the resistance increased or diminished to keep the strength of the current at a suitable medium, necessary alike for the reduction in the furnace and for the durability of the dynamo, the resistance box being used as an auxiliary governor in regulating the current. See REVIEW for February 26th, 1886.

CORRESPONDENCE.

The Tests at Messrs. Crompton's Works.

I think that all of us who are engaged in electric lighting will be interested in the tests which Messrs. Crompton have been good enough to publish; and I think, also, that many of us are indebted to you for calling our attention to the somewhat erratic nature of the tests.

The first point that strikes one, after a careful perusal of the figures, is how much farther advanced the infant branch of engineering is than its sisters. Though our instruments have an awkward trick of giving us different readings at different times, under the same conditions, more particularly if they have met with an accident in the meanwhile; yet there is no difficulty whatever in taking all the tests we require at any time, or in taking them continuously.

On the other hand, do you want to test the indicated H.P. your engine is furnishing, you become a perfect nuisance to everyone about. You require to exercise great skill and great care in making your tests, and in working them out. It is generally necessary to interfere with other work that may be going on, for fear that your tests may be upset. And, after all, what you have arrived at represents, in many cases, not the actual working conditions, but a special set of conditions that you have made for your test; and what is actually going on from day to day may be quite different to the results you have obtained.

Further, supposing that you are fortunate enough to obtain accurate results under actual working conditions, these may be altered even the next day by such a circumstance as is mentioned in the report, viz., that the boilers were not clean, or some part of the lubricating arrangements may not be doing its work properly.

One cannot help noticing, too, the striking irregularities in the speed; and I certainly agree with the remarks you have made that arrangements could have been made by lessening the load, if necessary, to keep the speed more constant; and that if this had been done the tests would have been far more valuable.

I hardly think, either, that the fact of the boiler not being up to its work is sufficient to account for the striking irregularities shown in the tables. As you have justly remarked, there is no load so easy to manage as an electrical one, under the conditions that ruled in this test. Practically, it might be taken as a constant load if the speed had remained constant; and in my experience I have always found that a heavy constant load was a very efficient governor.

A perusal of the figures will show, I think, that the variations of the exciting current were responsible for a good deal of the variation in the main current furnished. Presuming that the iron in the field-magnets and armature core was not saturated, an increase of the speed of the engine driving the excitor would lead immediately to an increased E.M.F. in the large dynamo and therefore to an increased demand upon the engine driving it, with the inevitable result that, if the steam did not follow, the speed would fall, and that is exactly what we find. We know, too, that a small engine, ungoverned, and with a light load, is very much more liable to variations of speed than a large engine working against a heavy load. I should therefore be strongly inclined to blame the government of the small exciting engine for the greater portion of the irregularities which are shown. Another point in connection with the exciting of the dynamo, which is probably due to an oversight, is that while the power used to excite the field-magnets has been carefully deducted from the output of the machine, no note has been taken of the I.H.P. consumed by the engine driving the excitor. Clearly this should have been added to the I.H.P. of the large engine, and the proportion that the measured output less what would have been used for exciting, bore to this total, would have been the measure of the efficiency of the system of engine and dynamo. Without this addition, the system is made to appear more efficient than it really is.

In fact, with this addition, the efficiency comes down to about 71·5 per cent. This, however, considering that it includes the combined efficiency of engine and dynamo is remarkably good. It would have been exceedingly interesting to have known the efficiency of the engine by itself, which could have been easily done by indicating the engine running light and deducting the power absorbed from the power absorbed when running with the full load.

Now as to the question of the coal. I note that the report states that the quantity of water evaporated ought to have given a coal consumption of 2 lbs. per I.H.P., and of 2·7 lbs. per E.H.P. if the boiler had been good.

I fear that practical works managers would hardly accept this. They do not want to know what *ought* to be, but what *is* the consumption under actual working conditions; and, unfortunately, the figures come out at 6·37 lbs. of coal per indicated H.P., and 8·65 lbs. per electrical H.P. at terminals of the machine, taking the figures as they are given in Table VI., or rather over this, if the correction for power consumed by the engine driving the excitor be taken into account. These figures hardly bear out Mr. Crompton's statement in the discussion on Mr. Kapp's paper at the Institution of Civil Engineers, that Mr. Willans's engines were delivering work at a consumption of only 3½ lbs. of coal per net electrical H.P. Of course, allowance must be made for the state of Messrs. Crompton's boilers, but as we can hardly suppose that Messrs. Crompton's boilers were in a much worse condition than the generality of boilers that are used to generate steam for industrial purposes usually are, I can hardly help thinking that it would be wise, in calculating the

cost of lighting, using these engines, to allow a pretty good margin for coming up.

As, too, 5 lbs. of coal per I.H.P. is the accepted standard for calculations, and is a standard that is supposed to err rather on the side of liberality in the quantity allowed, and this with ordinary engines that only use their steam once, while, with compound slow-speed engines, the consumption is very much less; it would appear, taking all things into consideration, that not much has been gained by the adoption of direct driving, even when in the hands of such competent men as Messrs. Willans and Crompton, and with all the assistance that the adoption of the compound principle gives.

The objections to high-speed engines, so far as I understand them, are threefold :—

First, they are usually more complicated; and if they do not present this disadvantage, they have some new arrangement which necessitates the employment of specially skilled labour should any little thing go wrong.

To those who, like the firm with which I am connected, have to not only supply those who would like to have electric light, but also to induce those who ought to want it, but are perhaps prejudiced against it, such a matter as that forms a serious consideration. It is one more point against us. Our friend perhaps knows nothing of dynamos, and if in addition we want to give him an engine that neither he nor any of his men understand, he will be likely to decline. He will await further developments.

The second objection to high speed engines is that, rightly or wrongly, they have the reputation of wearing out their working parts very quickly. Mr. Crompton related some rather discouraging experiences of his with one type of high speed engine in the discussion on Mr. Kapp's paper.

The third objection is that they use steam freely. This point the report says has been overcome in the Willans engine, only unfortunately the coal doesn't come out very well; and it is hard to dissociate one part from another. In most cases, water is cheap compared with coal. A manager would probably tell you that he didn't care a rush about the water consumption, what he would want to know would be what the coal was going to cost him; and it would not be of much use to tell him that if he had a different boiler he ought to get his power at 2 lbs. per I.H.P.; when at the trial at one of the leading works in the kingdom, one that is justly noted for its high-class work, the best that could be done was 6 lbs. odd per I.H.P.

One other point—what was the coal? A colliery manager showed me some the other day on his bank which he was glad to sell at sixpence per ton; while in the colliery districts generally, coal at 2s. 6d. a ton is generally used for firing. I presume, however, that at Chelmsford the cost would be very much in excess of this. The cheaper coal will, of course, not have the same heating power; but I think that to be of real service, the cost of an I.H.P. should be carried farther, and stated in terms of £ s. d., say in London, as it is obvious that work might be costing more in certain cases, although the consumption of coal might be less than in others, because one man was using a more expensive coal than the other, without getting a full return for the increased outlay.

Sydney F. Walker.

Cardiff, *May 4th*, 1886.

An Unexplored Field in Electric Lighting.

Your correspondent, Mr. Hamilton-Church, deserves the thanks of all electricians for the able and practical way in which he has discussed a question that has been indeed more than an open one—an untouched one, owing to the want of flexibility amongst English people in adapting themselves to circumstances. Because it has been hitherto impossible to obtain from Parliament the necessary powers to enable the formation of large lighting companies like the gas companies, English electricians appear to have tacitly agreed that electric lighting must be limited to individual large houses or large establishments, each taking a complete plant of its own.

I do wish some of our leading electrical lights, instead of driving ahead into the hidden mysteries of science, would devote their energies to studying the progress of electric lighting on the other side of the Atlantic, and adapting to English social life some of the clever contrivances and systems of the enterprising and successful Americans. To any Englishman acquainted with the boldness, ease and success with which the Americans put up and work electric light installations, the timorous, torpid manner in which our men here speak and think of the work is something deplorable.

As soon as a hundred houses get together in any part of the United States, down comes a contractor with an engine and dynamo and a gang of men; in a week wires are run everywhere, and the place is lighted up before an English firm would have got their estimate out; and the greatest secret of the American success is, that they are not afraid of the thing. They have reduced house lighting to as plain and practical a business as gas and water fitting, while we in England are still labouring under the impression that the electric light is a sort of "White Elephant"—very nice for those who can afford to lock up money in costly and complicated luxuries, but quite beyond the means of all who have not a national treasury at command, or something like it.

I want to see the electric light divested of the air of mystery that surrounds it in England.

If a builder wants 30 houses fitted up with gas, he does not begin by paying a troop of consulting engineers huge fees for drawing up idiotically complicated specifications for work that most ordinary working foremen can do by their own practical experience, and without any figures at all, but if he wants the electric light, Oh! that is quite a different thing, and cannot be approached without an amount of scientific palaver, and general expense and humbug, that would suffice to draw up a boundary line for a disputed territory.

Builders, as a class, are generally clever, enterprising men, and I do wish they could be brought to recognise that the amount of engineering skill required to fit up 30 houses with gas and water is amply sufficient to fit them up with the electric light. The electric light has passed the experimental process, and is as practical and matter of fact a business as the plumbing of a large mansion.

What I want and hope to see is the working electrical engineer forming as habitual a part of a good substantial builder's staff as the foreman carpenter or foreman mason, and that condition of things will come when builders recognise that such schemes as that of Mr. Hamilton-Church can be carried out by the builder himself from first to last, without any other technical aid than that of a working electrical engineer at about £2 a-week.

The builder can arrange for and construct his own engine house, he will know the number of lamps he means to have, one for each gas burner he would otherwise use, the makers will give him a lamp to give the same light as his ordinary gas burners, and will tell him the current and E.M.F. they want, and he can thus reckon for himself what ampères he must have, his electrician (if he be worth his salt) can tell him how much extra E.M.F. he must have to make up for loss through the cables, for the exact data are given in published tables that can be got through any scientific bookseller; he adds that to the E.M.F. of the lamps, adds on about one-fifth to both E.M.F. and current for margin (a thing which our highflown electrical engineers quite disdain, relying on the accuracy of their complicated calculations, and making some pretty messes in consequence), and writes to half-a-dozen of the principal electrical firms who make dynamos for prices for a machine to give that E.M.F. and current, and particulars of what horse-power and speed it will take. They will gladly supply this, and he chooses (if a wise man) a machine of middling price, neither the

most costly nor the cheapest, and then applies to some good firm of engineers for an engine to give that speed and horse-power, letting them know that he does not want an affair with a score of recently patented alterations—by courtesy, improvements—but an old-fashioned, simple, strong steam engine. They will supply him with this; in a similar way he can get what wire and cables he wants, for which he or his electrician can calculate in their heads from the published tables, and the rest he can do himself.

He can put down his own engine and his own dynamo, the electrician can lay the cable and wire and fit the houses without any other help than the builder's own men, and the whole 30 houses and installation be done and finished thoroughly well at about one-half what an electric lighting firm would charge, *e.g.*, the builder can do it for about £2 to £3 a lamp, where an electric lighting firm would charge £5 to £7; or perhaps he can do it for still less, for the cost diminishes wonderfully when a large plant is employed, and things bought in quantities.

For the success of the work technically, the great thing is: eschew all calculations that cannot be made in the head or on the back of a postage stamp, and have the wiring done by a man who has had a good practical experience; but not too much of it, not more than 10 years at the very outside; men who have been longer in the business than this are generally (as I have found by sad experience) as old-fashioned as fossils, and quite as obstinate, doing things not because their judgment tells them they are necessary, but because they have been used to doing them for 20 years.

For the success of the work financially, if anything is costly, do without it, and get something that is not costly; and especially eschew all recent patents and patented articles; do not be afraid of departing out of the beaten track, but copy the Yankee method; if you cannot do a thing one way because of the cost, be sure there is some other way, cheaper and as good, and set to work to find it or make it.

Now for a few practical details. In such an installation as Mr. Hamilton-Church describes, I should most strongly suggest the use of accumulators, for this reason: the best of engines *may* break down; the best of belts will break now and then; and the steadiest of engine men will get drunk now and again; and if the 30 houses are dependent for the light on the engine and dynamo keeping running, they will then be left in darkness suddenly, and there will be a row. If, however, accumulators are used, having storage power enough for one night's consumption, say, at most, eight hours in winter, falling to three or four in summer, they can be charged during the day, and at 5 o'clock the engine driver can lock up and go home, with the perfect certainty that the householders will have their light for that night at least all right, and, at a pinch, several hours the next day; so that if the engine should break down, there would always be time to repair it, or get a portable engine for the time. Moreover, the extra cost of these accumulators would not be very much, I think, because their use (enabling the employment of a much smaller and cheaper dynamo, and cheaper, simpler, and smaller engine, with the consequent saving of interest on cost price), would save a good deal of money in first outlay, and, as regards cost of cells, the builder could make these himself, just as he makes his doors and window frames.

His carpenters could make the cells, his plumbers the plates (pure lead), and, with the engine and dynamo required for the 30 houses, he could *form* his plates himself, at about one-third of the cost if bought. The old original Planté patent has expired long ago, and I believe I am right in saying (if not you, Sir, will correct me), that there is nothing legally to prevent any man making as many accumulators as he pleases by the old, but for excellence, unsurpassed process of forming the plates from the pure lead. The size of accumulators might be an element of inconvenience; but 30 houses, at twenty 16 C.P. lamps each, could be lit for something like seven hours by 50 cells of 3 feet dimensions every way.

Space will not permit of my going further into questions of cost and detail; but I may add two material points for the benefit of non-electrical readers:—

(1.) That these accumulators are simply reservoirs of electricity, just like the huge gasometers of a gas company, and are, to the full, as safe and steady; and when once put up require very little more than just to be *let alone*.

(2.) That electrical fittings for a dwelling house are perfectly compatible with gas fittings; the two could be put in together, so that if by any chance the electric light failed, or was discontinued, the gas would be always there, for ordinary gas fittings make capital supports for electric light wires and lamps, and save the cost of special fittings and chandeliers for the latter.

I must not trespass further on your valuable space, as I fear I have done too much already; but if you considered it advisable to open your columns to information on the subject, I should be pleased to put together some practical instructions for a builder in Mr. Hamilton-Church's case.

I do not hesitate to say, speaking from a considerable practical experience, that it is quite possible for a builder of shrewdness and ability to be his own electrical engineer.

Edward Conry.

23, Villiers Street,
New Bushey, Herts, *May 3rd*, 1886.

Electricity v. Heat.

Thanks for your having published my three letters containing particulars of experiments which prove that electricity and heat are two independent elements.

There is another fact bearing on this subject which is of much practical importance to those who are interested in the passage of electricity through wires. The published writings of the late Mr. Sabine show that in 1883 he had discovered that when a wire was part coated with India-rubber, and part left bare, and on a current of electricity being passed through this wire the part coated with India-rubber was 25 per cent. cooler than the uncoated part in contact with the air. A Mr. White has recently made similar experiments in America, and it is alleged that he found that when a wire of 65 mils. was part coated with a covering of 285 mils., and a current of electricity passed through this wire the uncoated part became three times hotter than the coated part. Now every electrician will admit that a wire with a coating of 285 mils. of good insulating material should retain within it more perfectly the current of electricity than the other part of the same wire which was exposed to the air.

This being admitted, it becomes manifest that the source of the heat cannot be in the electricity, or else the coated part of the wire would have become the hottest part instead of being the coldest. The explanation of this is through the fact proved by my experiments that electricity has a powerful attraction for heat. The current of electricity while passing through the uncoated part of the wire had free access to the air, and in consequence the electricity within the wire attracted to itself the latent heat of the air, and thereby the wire became hot: whereas the part of the wire coated with the covering of 285 mils. remained cool, because the current of electricity while within that part of the wire was prevented from attracting to itself the heat of the surrounding air, because the covering was interposed. The practical conclusion to be drawn from this is that the covering for wires should be air-tight, and non-conducting of heat as well as being insulating.

This subject has an important bearing on the recent experiments so ably carried out by Prof. Hughes.

A copper wire consists of three things—*first*, molecules of copper; *second*, latent heat; *third*, latent electricity. These three things in the normal state of the wire are all balanced and in a state of rest to one

another; but the moment an electrician forces a current of electricity into that wire the balanced state of the aforesaid three things is disturbed. When the forced current of electricity enters one end of the wire it attracts to itself a portion of the heat which had hitherto been at rest within the embrace of the normal electricity of the wire, and hence a new adjustment of the relative positions of the molecules of the copper, of the heat, and of the electricity takes place within the wire, beginning at the anode end and continuing to the cathode end of it. It is during this readjustment of the molecules of the foresaid three things that the wire is in that which has been called the variable state of it, and after the readjusted or new balanced condition of the three things has taken place the wire is then in that which is called the stable state.

James Johnstone.

8, Mercheston Park, Edinburgh,
May 3rd, 1886.

[Mr. Johnstone's explanation of the difference of temperature between the uncovered and covered portion of a wire through which a current is flowing is too absurd to be seriously entertained. If he will read a paper written by the late Robert Sabine, and published in our issue of January 6th, 1883, he will find therein the true explanation. Our correspondent has only sparingly favoured this journal with his fantastic theories, a matter of self-induction—we mean congratulation—and if he really desires to see his writings figure in our future issues they must at least be of a rational nature.—EDS. ELEC. REV.]

Electric Lighting on the Spey.

Perhaps a little further information with reference to the watt power for the above, mentioned in your notice last week, may prove interesting to some of your readers.

The arrangement in question was designed by me for the electricians Messrs. Craven and Elworthy.

The problem was to provide a simple and inexpensive, but efficient plant; to obtain the required power with a moderate fall. To meet these conditions a turbine was employed set open in a penstock. All toothed gearing was dispensed with and the power conveyed to the dynamo by belt. In this manner silent running was ensured. The arrangement is the best and most simple which can be employed for a low fall. There are, however, numerous instances where a high fall and limited quantity of water are more readily available. In such cases I prefer to lay a large water main for the triple purpose of water supply for domestic use, fire service, and as a conduit to a high pressure turbine for driving the electric machinery.

The turbine and dynamo may be fixed in any convenient outhouse and attended to by any "odd man" about the house. I would, however, add a word of warning. The size of pipe should be fixed by the maker of the turbine, with full knowledge of the height of fall, length of pipes and power required; otherwise they are liable to be laid too small. In fact, mistakes of this kind have even been made by makers of turbines whose experience has been but limited.

Charles L. Hett.

Brigg, *May 3rd*, 1886.

The Electric Light at Sea.

I have just read, in your current number, with pleasure the article on "The Night Passage of the Suez Canal," and would be very thankful if you or any of your contributors could give me in an early issue the *longest known* distances the electric light has been seen at sea on board ship or on land. A few "wrinkles" on either or both these points would be esteemed by

P. M. Purves.

Salford, *May 3rd*, 1886.

Electric Locomotion.

I read with great interest a note in your last issue respecting a trial trip of one of the Electric Locomotive and Power Company's engines, but was rather surprised to notice that all details of energy absorbed, rate of speed, &c., were omitted. However, I find these particulars noted in a weekly local paper, as follows:—

"A most important matter was the fact that the quantity (*sic*) of electrical energy used was considerably less than was expected, the running on the level road taking only 25 ampères and on the gradients from 40 to 65 ampères, and down hill no current whatever."

This represents a minimum rate of 4·6 E.H.P. on the level and a minimum of 12·1 E.H.P. upon the gradients.

Mr. Reckenzaun in his able articles upon electric locomotion in your valuable journal of February 26th, page 168, states most emphatically that a separate electric locomotive is a wasteful method of applying electrical power to tramway haulage. I have always considered Mr. Reckenzaun to be a recognised authority upon this subject, and am the more surprised to find that an apparatus which must necessarily weigh more than double the weight of the Reckenzaun motor and gearing should show a better result with much greater economy.

Another paragraph in the aforesaid local journal states that—

"Owing to the small amount of current used, no appreciable difference could be detected in the storage batteries, and at least seven or eight hours constant work could have been performed without any fall in their energy."

This is a plain proof, if correct, that the separate electric locomotive is the only successful method of applying electrical power for tramway propulsion. I am anxious to know how this marvel is accomplished, as I am deeply interested in the progress of electrical locomotion, and have hitherto believed that the motor fixed under the car itself was the best arrangement for the purpose, and in which I was confirmed by Mr. Reckenzaun's articles upon the subject.

Alfred Melhuish, *Mech. Engineer.*

Suggestions as to Testing Incandescent Lamps.

I have read Mr. Shippey's suggestions as published in your last week's issue relative to the above subject, which certainly open up a field for discussion, as some points suggested by him are novel.

There is, undoubtedly, a very great difference in the results obtained from one maker's lamps over another, even when marked the same voltage.

I have recently carried out a small installation with ½ H.P. Otto gas engine, driving one of Messrs. Greenwood and Batley's 750 watts dynamo machines, wound for 40 volts at 15 ampères; speed, 2,000 revolutions. I have tried several makers' 40 volts lamps, including the Swan, Woodhouse and Rawson, Gresham, and Shippey's; the latter lamp, I am bound to say, gives the best results. I was recommended by Messrs. Shippey Bros. to alter the pulley of the dynamo so as to run same at a slower speed, and use 30 volt lamps instead, which I did, and now run 14 lamps of 16 C.P. It is true, my lamps are somewhat overrun, but they stand it, and I get a more brilliant effect; I am satisfied with the result.

Messrs. Fuller and Son, of Finsbury, have a similar installation, using 30-volt lamps, but they use 16 accumulators, charged a few hours daily, which enables them to light over 30 lamps on two circuits for lighting their premises in the evening; these results are remarkable from a small ½ H.P. gas engine, and I know of nothing to equal this for small installations, and it clearly proves the advantages to be obtained in point of economy by using low resistance lamps for small domestic lighting installations over that of high E.M.F.

Frank Bilton.

May 4th, 1886.